SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

Published every Friday by

THE MACMILLAN COMPANY, 66 Fifth Ave., New York

*TO OUR READERS.**

The experience of centuries shows that great success in advancing scientific knowledge cannot be expected even from the most gifted men, so long as they remain isolated. The attrition of like minds is almost as necessary to intellectual production as companionship is to conversation. The commencement of the development of science on a large scale, and with brilliant success, was coeval with the formation of the Royal Society of London and the Academy of Sciences of France. When these bodies came together their members began to talk and to think.

At the present day one of the aspects of American science which most strikes us is the comparative deficiency of the social element. We have indeed numerous local scientific societies, many of which are meeting with marked success. But these bodies cannot supply the want of national cooperation and communication. The field of each is necessarily limited, and its activities confined to its own neighborhood. We need a broader sympathy and easier communication between widely separated men in every part of the country. Our journal aims to supply the want of such a medium, and asks the aid of all concerned in making its efforts successful. It will have little space for technicalities which interest only the specialist of each class, and will occupy itself mostly with those broader aspects of thought and culture which are of interest not only to scientific investigators, but to educated men of every profession. A specialist of one department may know little more of the work of a specialist in another department than does the general reader. Hence, by appealing to the interests of the latter, we do not neglect those of the scientific profession. At the same time, it is intended that the journal shall be much more than a medium for the popularization of science. Underlying the process of specialization, which is so prominent a feature of all the knowledge of our time, there is now to be seen a tendency toward unification, a development of principles which connect a constantly increasing number of special branches. The meeting of all students of nature in a single field thus becomes more and more feasible, and in promoting intercourse among all such students SCIENCE hopes to find a field for its energies, in which it may invite the support of all who sympathize with its aim.

*From the Introduction to the new series of SCIENCE by Professor Newcomb.

An Advertisement of SCIENCE

SCIENCE is about to complete its twenty-second year of publication and the twentieth volume of the new series. When the journal was established, in 1883, it was at once accepted as the organ of American men of science. Edited by Mr. S. H. Scudder, it early numbered among its contributors nearly all the leading scientific men of the country. The officers and directors of the JOURNAL were: President D. C. Gilman, *President;* Professor Simon Newcomb, *Vice-President;* Hon. Gardiner G. Hubbard, Professor Alexander Graham Bell, Professor O. C. Marsh, Major J. W. Powell, Professor W. P. Trowbridge and Mr. S. H. Scudder, *Directors.* The sum of eighty thousand dollars was spent in the establishment and support of SCIENCE by Professor A. Graham Bell and the late Mr. Gardiner G. Hubbard. Large as the sum may appear, it is small in comparison with the value of the JOURNAL to science in America.

The first series of SCIENCE.

SCIENCE was reorganized ten years ago, and has since been under the charge of an editorial committee, consisting of the leading men of science of America. It has, during this period, adequately and fully reflected the progress of science and has been an important factor in its advancement. Its contents have maintained a high and even standard, comparing favorably with any journal in any country. It has stimulated scientific activity and interest in America, and has led to a fuller recognition of American science abroad.

The new series of SCIENCE

A further important step in advance was taken in 1900 when the American Association for the Advancement of Science decided to publish in SCIENCE its official notices and proceedings and to send the journal free of charge to all its members. This was done without any increase in the dues for membership, which are only three dollars, as compared with five dollars in the British Association and four dollars in the French Association, and may be regarded as a notable triumph of scientific organization. The membership of the association increased from 1,721 in 1900 to 4,007 in 1903. It is expected that the members will number 5,000 within a year, and it is hoped that they will number 10,000 before many years have elapsed. In spite of the cost of supplying the journal free of charge to members the finances of the association are in better condition than ever before, the permanent secretary having been able to turn over each year a considerable sum from current expenses to the permanent fund.

The American Association and SCIENCE.

SCIENCE aims to give each week just what every one interested in the advancement of science should read. There are articles and addresses, often by our leading students of science, and always by the most competent writers. These do not conflict with the contents of the special journals, but offer the information and stimulus needed by those who wish to keep abreast of modern science. It is not necessary nor is it possible to give the names of those who have contributed and are contributing to SCIENCE or the topics that have been treated. The contributors include practically all Americans who are actively engaged in scientific work and a great number of the leading British and foreign men of science. The nearly fifty volumes that have been

Original Contributions.

published form a complete encyclopedia of the sciences, continually revised and brought to date.

Progress of Science.

While SCIENCE prints original contributions and has a special department for shorter articles where new discoveries and advances of general interest may be promptly announced, its more important office is to report on the progress of science. Each number contains longer articles and shorter notes which keep the reader informed on the main advances of science in all directions. The reports are not intended to be technical in character, being addressed to men of science working in other departments and to the intelligent classes of the community. Each week pages of items of scientific and educational news are published, which alone would make it essential for every one to read the journal who wishes to keep informed on current scientific interests and activity.

Scientific Literature.

Scientific books are reviewed weekly in SCIENCE, the most recent information and authoritative estimate of new publications being given. It is probable that no journal in America is able to publish reviews of such weight as those contributed to SCIENCE. While the special journals may give information regarding new publications in a single science, it is necessary for every one to know something of the more important books in other sciences, and for this purpose SCIENCE is essential. Some notice is also given of the contents of special journals and other smaller contributions which might otherwise escape attention.

Discussion.

The weekly appearance of SCIENCE, the wide fields it covers, and the fact that it is read by practically every one interested in scientific matters, makes it the best medium for discussion and correspondence. This has been generally recognized and the department usually contains contributions of great interest tending to promote acquaintance and intercourse between men of science.

Organization of Science.

All matters relating to the organization of science, associations, academies and societies, journals, universities, museums and other institutions, both here and abroad, the scientific departments under the government, legislation and related subjects have been fully reported and discussed in SCIENCE. Thus, for example: The American Association for the Advancement of Science, the National Academy of Sciences, the various national societies devoted to a special science, the state and local academies and societies, have had their proceedings reported, and not by writers for the press, but by officers of the societies. Editorial articles and notes have been prepared, whenever it was thought that the weight of the JOURNAL should be used for the defense and advancement of scientific interests.

The Future of SCIENCE.

The past history of SCIENCE is a sufficient guarantee of its future usefulness. Such a JOURNAL is essential to the advance and proper recognition of the scientific work of each country, and in America, where men of science are scattered over a great area, with no single center for personal intercourse, it is peculiarly needful. With the growth of science and scientific institutions in America, SCIENCE will occupy an even more important position than at present. It will continue to set a standard to the popular press in its treatment of scientific topics, to secure that general interest in science so essential to its material support, to enlarge the place of science in education and in life, and to demonstrate and increase the unity of science and the common interests of men of science.

The gradual increase from year to year in the subscription list of SCIENCE has been most gratifying to the publishers. The journal is as truly an educational institution as is a university, a museum or an academy of sciences. That it should be securely established without endowment or subsidy proves that it has met a real demand and at the same time that there is a genuine and widespread interest in science in this country. Every new subscription not only strengthens the position of the journal, but also tends to promote the advancement and diffusion of science. The weekly issues of SCIENCE should reach :

(1) All men of science. For most of them it is a privilege to support a journal devoted to their interests and through it to follow the general forward movement of science and scientific organizations and institutions.

(2) Physicians, engineers and other workers in the applied sciences, it being of importance that science and its applications and the men who are advancing each should be kept in touch.

(3) Professional and business men who take a broad view and wish to keep informed on the progress of science, probably the most important factor in modern civilization. The weekly journal in Great Britain corresponding to SCIENCE is subscribed for by thousands of people of intelligence and culture who have no direct interest in science. It would contribute largely to the advancement of science if a similar group could be formed in the United States.

(4) All libraries, schools and other educational institutions should subscribe to SCIENCE. The journal will be found in the larger libraries, but should be accessible everywhere.

SUBSCRIPTION ORDER

The Macmillan Company,

66 Fifth Avenue, New York

Please find enclosed .... for five dollars subscription to SCIENCE for one year, beginning ....

Name ....

Address ....

City and State ....

Date 190

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

FRIDAY, JANUARY 5, 1906.

CONTENTS.

The American Association for the Advancement of Science:—

The Popular Conception of the Scientific Man at the Present Day: PROFESSOR W. G. FARLOW 1

The Problem of the Metalliferous Veins: PROFESSOR JAMES FURMAN KEMP 14

Scientific Books:—

Heilprin on the Tower of Pelée: ERNEST HOWE. *The Belgian Antarctic Expedition:* PROFESSOR W. H. DALL 29

Scientific Journals and Articles 31

Societies and Academies:—

The Geological Society of Washington: ARTHUR C. SPENCER. *The Kansas Academy of Science:* PROFESSOR E. H. S. BAILEY ... 32

Discussion and Correspondence:—

Isolation and Evolution: EDWARD W. BERRY. *On the Human Origin of the Small Mounds of the Lower Mississippi Valley and Texas:* A. C. VEATCH 34

Special Articles:—

The Terminology of Aberrant Chromosomes and their Behavior in Certain Hemiptera: PROFESSOR THOS. H. MONTGOMERY, JR. 36

Scientific Notes and News 38

University and Educational News 40

MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

THE POPULAR CONCEPTION OF THE SCIENTIFIC MAN AT THE PRESENT DAY.[1]

WE are so accustomed to hear reports on the progress of science that we have almost ceased to ask ourselves what we mean by progress. What is or is not progress depends of course on the point of view. Some are so far ahead of the majority that they can not see how much progress is made by those behind them; others are so far in the rear that they can not distinguish what is going on ahead of them. We must also admit that there are different directions in which progress may be made. You have all seen the agile crab and been surprised to find how rapidly he gets over the ground, although he never seems to go ahead, but to scramble off sideways. The crab, perhaps, wonders why men are so stupid as to try to move straight forward. It is a popular belief, but, not being a zoologist, I am not prepared to vouch for its correctness, that the squid progresses backward, discharging a large amount of ink. One might perhaps ask: Is the progress of science sometimes like that of the crab, rapid but not straight forward, or, like the squid, may not the emission of a large amount of printer's ink really conceal a backward movement? So far as the accumulation of facts is concerned, there is a steady onward progress in science and it is only in the unwise or premature theorizing on known or supposed facts that science

[1] Address of the president of the American Association for the Advancement of Science, New Orleans meeting, 1905.

strikes a side track or even progresses backward.

As far as botany is concerned the progress during the past year has not been startlingly rapid, but it has been in the direction of an accumulation of facts rather than in the formulation of new theories and the enunciation of general principles, very important if true, but unfortunately not always true, as time shows. If there have been no remarkable discoveries in botany during the past year, on the other hand it may be said that few of the steps which have been taken will need to be retraced hereafter. What strikes one most in a survey of the botany of the present day is, I think, the fact that it is becoming more and more difficult to say just what is and what is not botany. Formerly all botanists were cast in pretty much the same mold and, as a science, botany was sharply limited except, perhaps, in the direction of zoology. One could pass for a very good botanist, although quite ignorant even of the rudiments of other branches of science. Now we often see in botanical journals papers which might almost as well have appeared in physical or chemical journals and in many cases one is not at liberty to form a final opinion as to the value of a paper purporting to be botanical until physicists or chemists, or perhaps both, have also expressed their opinions in regard to it. In short, the hard and fast lines which formerly shut botanists up in a world of their own have been broken down and botany has become an inseparable part of a broader science. This enlargement of the botanical horizon resulting from the gradual shading off of the confines of botany into the domain of other sciences not only tends to make it more attractive to botanists themselves, but also serves to add dignity to botany in the eyes of those who are not themselves botanists. Young botanists with a modern training may be permitted to feel confidence in entering on so broad a field, but those who are no longer young and whose training was that of the old school, no matter how much they may sympathize with modern conditions, can not help feeling distrustful of their ability to judge critically of work done in so many new directions and by so many diverse methods. Botany has, in fact, become so broad a science compared with what it was not many years ago that no one man can be expected to be in position to judge critically of work done except in certain branches of the subject. Consequently there have been formed a number of societies each devoted to a special department of botany and, if one wishes to know what is going on in botany, one is forced to attend the sessions of the societies affiliated with the association as well as those of our botanical section. It is to the presiding officers of those societies and of the botanical section that one must look for anything like adequate presentations of the present state of botany. The views of one man are not sufficient, but he who would acquire a broad view must listen to the representatives of different branches. It seemed better, therefore, that, departing from the practise of my predecessors, I should not attempt what can be done better by others, and I have selected for my subject not the present condition of botany, but another topic which ought to interest us all, viz., the scientific man, what he is believed by the public to be and what he really is. Do not, however, suppose that I am about to regale you with personalities concerning my contemporaries. I wish merely to call your attention to the estimate which the public place on scientific men as a body and to consider the question whether they really understand the aims and needs of persons like ourselves.

You must have noticed in reading the magazines and papers that a change has

recently come over the public in their attitude towards us. They believe that they have really discovered what we are, they recognize that we are more respectable than they used to suppose and the question has been asked more than once: What shall we, the public, do to help scientific men? That that question should be correctly answered is certainly of extreme importance to us. It is, therefore, worth our while to consider the recent change in the attitude of the public toward us, the question how far that attitude is correct from our point of view and how far their ideas of what should be done for us correspond with what we really desire and need.

First, what do they think of us? The lights, or the supposed lights of science, have always been objects of interest to the world. The mass of scientific men have, on the other hand, counted for little. The public have always needed some idols to worship and in their indiscriminate collection of gods there have always been a few taken from the scientific world. Their wonderful achievements have been magnified beyond all recognition, their precocious sayings have been recorded and their opinions on theology, music, politics and many other subjects about which they knew nothing in particular have been paraded before us. Once in a while when the flashlight of the caricaturist has been thrown upon them, they have been shown to have some human weaknesses and the learned professor who is supposed to be discussing evolution or the vortex theory with his neighbor at some fashionable reception has been represented as really only making remarks about the ladies present while imbibing fluids which it is said retard rather than aid the metamorphosis of brain tissue. Those who were not so fortunate as to be counted among the lights of science were passed over as having perhaps an academic importance, but of no account in the real world, being both impractical and impecunious. The question, what is the good of science, was supposed to be unanswerable and it seemed to follow as a corollary that a man who spent his time on things which were good for nothing must himself be good for nothing.

All that has changed and the traditional scientific man has disappeared almost as completely as the traditional Yankee of the stage. The change came gradually but the proof that it had come was brought before us suddenly. In 1902 there was called in New York a meeting of those who were designated by the picturesque expression, captains of industry. To that meeting representatives of science were invited, not as lions to be stared at, but to sit with the leaders of the industrial and commercial world as representatives of science, and not only of applied science, but of pure science. As the captains of industry were supposed to be men of force in organizing and to have a keen insight into men and things, we had a right to feel that science was honored, perhaps not more than ever before, but for a reason for which it had not been honored before in this country. The fact that since that date the reputation of some of the captains of industry has suffered an eclipse, does not alter the fact that to be considered a captain of industry was, in the eyes of the public, enviable. The conception of a scientific man as a captain of industry means simply the acknowledgment that science has a practical relation to the world and that fortunately the public have advanced far enough to see, although perhaps somewhat dimly, that pure science sooner or later develops into applied science. The leaders of science are to be placed in the class of organizers, managers of a sort of scientific trust. This is science up to date and the public are right when they regard science as an organization. But they are only partly right.

There is a good deal more than that in science and, although good managers and directors are necessary, it is true that the power of organizing and the power of investigating are two different things and often exist in inverse ratio to each other, and it is the latter which is at the basis of science. An organizer is of no use until there is something to organize and the materials on which the organizer in science must work are not made by machinery, but by the brains of individual workers, and it is important that they should be placed under the most favorable conditions for work. If hitherto there has been perhaps too little organization, there is a danger that in the future there may be too much. In a mill many men are doing the same kind of work, but in science one man should not duplicate the work of another. The object of organization in the one case is to secure uniformity of product; in the other to encourage diversity of work.

You have seen the statement in print that there are not enough workers in science and it has been claimed that the rewards are so inadequate that many young men can not afford to enter on a scientific career. It has been proposed to remedy that difficulty, and we not infrequently hear that something should be done by the public. So far nothing very definite has been proposed. It has been suggested that scientific men should be better paid. Against that we have absolutely nothing to say, but we are waiting a little impatiently to learn how they are to be paid. The captains of industrial establishments make large fortunes and it seems to be a principle of economy that in the management of other people's money a pretty large proportion finds its way into the pockets of the managers. Others who probably recognize the obstacles in the way of arranging that scientific men shall be better paid would solve the difficulty by having a limited number of great prizes to be awarded at intervals.

It is certainly pleasant to know that the public would like to do something for us, for with the intention may come later the fulfillment. But it may be well to look into the matter a little more closely. In the first place, assuming that more men ought to go into science, it is by no means certain that, were the remuneration much greater, the right kind of men would go into the field. It would be an easy matter, if the pecuniary rewards were great enough, to induce any number of men to go into science, but a man in search of money is not ever likely to do the best work in science. Unless a man has a love of science for its own sake, apart from the money he is to make out of it, he must be classed as a business man and not a scientific man. A more important point to ascertain is how many men with a strong desire to study science and with good ability have been obliged to abandon its pursuit and gain their living in some other way. There are certainly some, but I am unable to form a definite idea as to the number. There are undoubtedly a good many men in the field struggling under difficulties which keep them from doing the best work of which they are capable. Before attempting to draw more men into the field it would be better to provide properly for those already in it.

Little need be said on the subject of a limited number of great prizes. So far, we are in the dark as to what the prizes are to be. We can not, of course, adopt the plan established in some countries and bestow on a few favored sons of science titles of nobility or knighthood. This method of rewarding merit has something to be said in its favor. It costs the bestower nothing and pleases the recipient. A chemist with a decoration round his neck is, of course, distinguished at once from

other chemists. A physicist in knee-breeches and an embroidered coat is imposing and, if a cocked hat under his arm be added, quite irresistible. But all this glory is not for us in this country—as yet. Nor can we expect that the coveted title of Geheimrath will be bestowed by our government. The great prizes must necessarily be in the form of money, either as pensions or gifts. To have any real value a pension must be something of which both the amount and the date on which one may count with certainty on receiving it are fixed years in advance. To expect a pension, which some one else may receive, is hardly a consolation. If money is to be given outright how much is necessary to be considered a great prize? When we consider that even incompetent presidents of insurance companies consider their services cheap at a hundred thousand a year, one wonders what sum would be considered a proper reward for years of valuable work done by competent scientific men during the best years of their lives. Even at the best, the most that could be given to scientific men would be a mere pittance compared with what the other captains receive. It is unnecessary to try to answer the question, even if modesty did not forbid, for the principle of bestowing a few large prizes with the expectation of benefiting science is a delusion and it is to be hoped that no benevolent person will make the mistake of establishing one or more great prizes. What is wanted is not the possibility of sometimes receiving a large sum, but the certainty that the amount received annually will be sufficient to enable one to live and work without discomfort in the present and without anxiety for the future.

The ways in which the public may aid scientific men are directly by endowments for paying salaries and indirectly by providing properly equipped laboratories and other necessary equipment, and especially for paying for the services of assistants. Both forms of help are necessary, for a man capable of managing and getting the greatest amount of good work out of a well-equipped establishment deserves more than a meager salary. On the other hand, those with what appears to be a respectable salary may have to spend a good part of it to make good the deficiencies in their equipment. In deciding whether a man is well paid or not it is necessary to ask not only what salary he receives, but what are the means of work provided for him. It is not my intention here to call attention to the special ways in which scientific establishments would be benefited by gifts from the public nor to discuss the question what is a proper salary for a scientific man. The latter depends upon too many complicated conditions and can not be separated from the more general question of what those in equally important positions in other walks of life are paid. The question of proper equipment, including the question of assistants, has already been brought before the public on a good many occasions and in a good many ways, and a good deal has been given in recent years, although by no means enough.

If, as it appears, the public have reached a better conception of the position of the scientific man in this country and of his pecuniary needs, it may be added that he has the right to hope that he can appeal to the public not only for pecuniary but for moral support, for, in many cases, the public are the final arbiters where differences arise and unfavorable conditions often disappear quickly as soon as it is felt that one side or the other is backed by public opinion. It may, therefore, be well to state somewhat explicitly some of the conditions which are unfavorable to the progress of science in this country or which tend to retard it. Here it is not so much a question of money as of a just appreciation of

the true position of scientific men in their relation to those for whom their work is undertaken. That work, using a rough classification, may be considered under three heads: that done in technical and commercial concerns, that done for the government and that done in universities, including under that general term all colleges, scientific schools and similar institutions which have a permanent endowment of some kind.

In chemical, electrical and mechanical engineering works and other essentially commercial undertakings the scientific man is occupied mainly with routine duties and the number of persons employed in this kind of work is large and will be much larger in the future. The ratio of demand and supply in this case must always regulate the salaries paid and, as scientific experts are a necessity in these lines of business, the pay ought to be expected to be comparatively as good as in other branches of business. Occasionally, as we have seen recently in the case of electrical engineering, the supply may become suddenly greater than the demand in the lower grades of work, but these things soon regulate themselves. Hitherto the value of biological work in connection with waterworks and other hygienic establishments has not been as fully appreciated as it should be and the openings for specialists in biology have not been very numerous. There has been, however, a change for the better in this particular field. It is not, however, with the case of those whose work is what may be called routine work that we are concerned here, but we must ask why it is that, in those occupations which are primarily money-making, Americans have been so reluctant to employ original investigators for the purpose of developing their business. For a good many years the great value of original research in connection with manufacturing concerns has been fully recognized in some European countries. The Carlsberg laboratory at Copenhagen is a brilliant example of how much scientific work by experts of reputation can aid a practical industry, and we all know how the employment of experts to investigate special questions has helped the Germans to coin money in chemical industries. We shall have to admit that in certain respects we are more stupid than some other nations. I have heard of an important firm engaged in the manufacture of chemicals who could not be persuaded to employ a competent chemical investigator, not a mere analyst, to develop their business, because they felt unable to pay the princely salary of $1,500 a year. This is the same kind of stupidity which seeks to secure foreign trade by sending out agents who are unable to speak a word of the language of the country to which they are sent. If our business men are too stupid to take advantage of the help afforded by science, although informed as to what is done by their foreign competitors, we shall not be called on to shed many tears over their ultimate failure in the competition for business.

The relations of the national government to science and to scientific men are most important, but unfortunately very perplexing on account of the numerous complicated conditions which have to be considered. Although the government is concerned only incidentally with science, it has in its service more scientific men than any other institution. I have said that the government is only incidentally concerned with science, believing that the object of government is to take charge of the work of administration entrusted to it by the constitution and acts of congress. Varied as this work may be, it does not include everything. For instance, the education of the country is fortunately not entrusted to the national government and the busi-

ness of education belongs to the states and the people in general. The theory that any department or departments of the government are to serve as universities for the scientific training of young men is, it seems to me, false. The government may properly give information to the public on certain questions and, in this sense, it may be regarded as educational, but these questions arise in connection with definite special problems which necessarily affect the whole country, such as the subject of epidemic diseases of animals and plants and their prevention, questions concerning the preservation of forests, of irrigation and similar subjects which from their nature are of immediate national importance. This view, however, is not accepted by many, perhaps a majority of scientific men connected with the government. There is something in the air of Washington which seems to make it inevitable that those in the government employ should believe that it is the business of the government to undertake or control all scientific work. In some cases this belief has been carried so far that attempts of the states or universities to carry on explorations or special investigations have been regarded as an encroachment on the field belonging by right to the government, and no sooner has some university or private person sent out a party of explorers than a rival party has been sent out from Washington. There is a tendency to forget that there are several millions of people in the United States not connected with the government and that large sums are furnished by institutions and private individuals for the study of scientific questions which can perfectly well be investigated without supervision from Washington. It has been said that the government has at its disposal more money than any state or institution, and therefore it is better able to do all kinds of scientific work. This conclusion does not necessarily follow from the premises, for the questions arise: Is the money voted by Congress as likely to be spent as economically as the amounts available in institutions not under government control, and, in general, is the concentration of scientific work under the government as advantageous for the development of science in this country as a proper distribution of the work among a number of independent institutions? Outside Washington there is a belief that, in accomplishing scientific work, a given amount appropriated by a university or other endowed institution will go farther than the same amount obtained by vote of Congress. In its fiscal arrangements the government treats the appropriations for scientific purposes as a part of a general budget, and the annual appropriations which become available in July lapse unless spent before the following July. Suppose then it is estimated that a given scientific investigation will require a certain amount of money. If that amount is voted it must be spent before the end of the fiscal year, and there is no doubt that it will be spent in some way or other. But, unfortunately, scientific investigations usually require a good deal of time and often very much more time than was anticipated. As a result, there must be additional grants, and to obtain them there is a great temptation to show that something has been done by printing reports of unfinished work. Outside the government departments grants made for a special investigation do not lapse at the end of the fiscal year and such investigations can, therefore, be planned more intelligently and carried out at a less expenditure of money. Also, in the matter of printing, the expense under the government is very great, owing to the large editions which are necessary. In the case of the better scientific works with numerous plates the great size of the edition, which

must be larger than required to supply copies to those really competent to appreciate the work, implies a pecuniary waste. But there is still the important consideration that in attempting to extend the work in too many directions, acting on the theory that the government should do all kinds of scientific work, the point is soon reached where no department and no bureau can be expected to do the work well, and what might be done well suffers by being weighted with what can not be done well. We have seen bureaus which, after acting for some years on the theory that any question theoretical or practical which could possibly be construed as having any relation to its work should be undertaken, finally break down under the weight of the impossible task and at last settle down to their legitimate, special, practical work. If one glances over the large mass of scientific publications of the different departments one can hardly fail to recognize that the most valuable are those which treat of special questions in applied science which have been conducted with a view to furnish information on subjects coming within the legitimate limits of investigation by the government, since the material to be studied can be better obtained by the government than by state or private institutions. The publications on pure science or on subjects not having a practical bearing are certainly no better, if, as is sometimes the case, they are as good as similar publications from other sources. Briefly, it seems to me that it would be no worse for the government and better for the science of the country in general if the scientific work done by the government were not spread over so wide a field. It will be said that the universities are also ambitious and attempt to do more than they can do well, which is perfectly true, but that is no reason why the government should make the same mistake.

The consideration of the attractions offered by scientific work under the government and the relations of the scientific corps to their superior officers is rather a delicate matter, for, while one may be allowed to speak of the advantages, as soon as one ventures to hint that there may be disadvantages he is likely to be told that he does not understand the situation. We can only say that, if the scientific employees of the government are perfectly satisfied with their positions and regard them as ideal, they are decidedly more fortunate than their fellow scientists in other places. What attracts men to Washington is not primarily the salaries, except in the case of young men just beginning their scientific careers, although in general salaries are not so small as has sometimes been supposed. Nor does the fact that the few, like the heads of bureaus, who receive large salaries are overwhelmed with administrative work prove that they are worse off than the better paid professors in universities where, until recently, with the higher salaries went more lecturing and more committee work. In the universities, however, this state of things is gradually improving, but it is difficult to see how it can change in the government departments. The salary which the average man can expect is small and, if held to strict accountability for his time by the department in which he may be, he can not add to it by outside work or, if he does, he may be called upon suddenly to explain. The attractions are the freedom from lectures and class work, although this is to some extent counterbalanced by a large amount of official correspondence, and the possibility of having clerical and mechanical assistants to aid him in his work. A still greater attraction probably is the fact that one will at not infrequent intervals be sent, at government expense, on a mission of some kind to different parts of the country or abroad, an arrange-

ment which relieves the monotony of routine work and enables one to see more or less of the world. In some universities the professors are allowed a year's absence once in seven years, but they are then generally on half-pay and have to provide for their own traveling expenses out of a reduced income.

There is supposed to be a certain glamour attached to government positions in all countries, but, as far as scientific men are concerned, those in government employ have, like others, to depend for their reputation on their merits rather than on their positions. Even in the case of Germany, where it is generally supposed that official positions are more highly esteemed than in this country, to be a professor in one of the leading universities is a distinction as great as to be a government official, that is, in the capacity of a scientific worker. There is a certain class of men who would always find Washington more congenial than any other place. To them the interviewing of members of Congress and other officials is a pleasure. To them the newspaper correspondent is always welcome. Although they may have great scientific and administrative ability which enables them to accomplish a great deal of good work, they are so constituted by nature that they never can be quite contented unless they have the opportunity of mixing in the stir and bustle of the world and of being heard of men and seen of women. This class of men is a small one and, I am inclined to believe, is growing smaller. It does not include the great majority of those whose work is of the most value to the government. This large majority prefer conditions which allow them to work in peace and quiet, and security of tenure in office without the feeling that sooner or later there may be an overturning of some kind is what they desire most in addition to adequate salaries. This possibility of some unexpected change in policy is the great disturbing feature in Washington, and that such changes must occur sooner or later is inevitable because the atmosphere of Washington must always be political. This does not mean that the scientific men employed by the government need concern themselves with politics. In the past that may have been the case, but there is no reason to suppose that at the present day a botanist would have to be a Republican botanist or an entomologist a Democratic entomologist to be sure of his position. Nevertheless, politics must always be a disturbing element because the scientific workers must be assigned to some bureau of some department, and the secretaries, the heads of the departments, are always politicians and always will be. I do not intend to use the word in its degraded sense, although it might be going too far to use the word statesmen as applied to all secretaries. At any rate all will admit that they can hardly be expected to be scientific men or to have, except in very rare cases, any real knowledge of scientific subjects. They are appointed because they represent some political interest and change with the party and generally with the administration, so that their service is short. One secretary succeeds another at short intervals and the policy of one may not be the policy of another. One may believe that there can not be too much scientific work; another that science unless sordidly practical is worthless. The policy of launching out on scientific work of all kinds without regard to expense, on the ground that our country is rich and that there is no need of counting the dollars and cents, is sure to be followed by indiscriminate retrenchment. In any case a secretary is obliged to look out for his own interests in relation to his party and in political crises no one can tell what may be done. Suppose that the presidents of all universities were

changed once in four years and that the new presidents had power to change the policies of their predecessors at once. One could easily imagine that scientific work would suffer.

The permanency of tenure in the government is supposed to be secured by the civil-service regulations and these regulations have undoubtedly improved the condition and raised the quality of government employees, but, so far as securing trained scientific men is concerned, the system, however well it may work in the case of clerks and low-grade positions, is not one which is so well adapted to the cases of positions requiring special scientific training. The recommendations of those under whom a man has studied or for whom he has worked would appear to be of more value than successful answers to a number of more or less stereotyped questions. The system, while it may keep out a very poor man, does not necessarily secure a very good man, unless, in some way unknown to us, the difficulties of a rigid system are softened by a beneficent interpretation of the rules. The civil service system, although acting somewhat to the disadvantage of a scientific man so far as entering the service is concerned, is on the other hand undoubtedly a protection to him during his service.

A recent executive order, however, seems to us to be a most unfortunate step backward, and, whatever may be said, must inevitably cause a feeling of insecurity. From the somewhat vague accounts given in the papers at the time of its promulgation one would perhaps not have been warranted in forming an opinion concerning the precise object which it was designed to accomplish, but the explanation of the order given in the president's recent message is, of course, authoritative. It is as follows:

Heads of executive departments and members of the commission have called my attention to the fact that the rule requiring a filing of charges and three days' notice before an employee could be separated from the service for inefficiency has served no good purpose whatever, because that is not a matter upon which a hearing of the employee found to be inefficient can be of any value, and in practice the rule providing for such notice and hearing has merely resulted in keeping in a certain number of incompetents, because of the reluctance of heads of departments and bureau chiefs to go through this required procedure. Experience has shown that this rule is wholly ineffective to save any man, if a superior for improper reasons wishes to remove him, and is mischievous because it sometimes serves to keep in the service incompetent men not guilty of specific wrongdoing. Having these facts in view, the rule has been amended by providing that where the inefficiency or incapacity comes within the personal knowledge of the head of a department the removal may be made without notice, the reasons therefor being filed and made a record of the department. The absolute right of removal rests where it always has rested, with the head of a department; any limitation of this absolute right results in grave injury to the public service.

The justice of the last sentence is beyond question. There is, however, another absolute, moral right which is not mentioned in this connection, viz., the right of a person accused to be heard in his own behalf by the one in whom the power of removal is vested. The expression inefficiency or incapacity coming within the personal knowledge of the head of the department, taken in connection with the previous statement that experience has shown that the rule requiring three days' notice is wholly ineffective to save any man, if a superior, for improper reasons, wishes to remove him, suggests several unpleasant possibilities. In the first place one regrets hearing that it is not only possible that persons might be removed for improper reasons, but especially that experience has already shown that the previous rule was powerless to prevent such removals. Stated baldly, experience has shown that persons have been removed for improper reasons since the establishment of the rule. By whom, one

would like to ask? By the heads of departments in whom is vested the absolute power of removal? The expression, personal knowledge of the heads of departments must, in the case of scientific employees, be taken to mean indirect rather than direct knowledge, since they are not themselves scientific men and must practically obtain their knowledge of one scientific subordinate from other subordinates, and this is an additional reason why, when it is a question of removing a scientific man, he should be allowed to state his case to the head of the department and, if he is charged with misdemeanors of any kind, be informed by whom the charges have been made. It is evident that the new order has caused some criticism, since what was said in the message was not merely explanatory, but also in the nature of a defense. It is sincerely to be hoped that this order, embodying as it does a principle which may in practise cause injustice, may be revoked and something more specific and less sweeping be substituted for it. It is useless to say that there is no danger that the rule will be applied except in cases where the incompetency or indiscretion is quite plain. So long as it exists, knowing the weaknesses of human nature, there is always a danger that it may be applied in a way to cause injustice.

Turning to the universities and other similar endowed institutions we also find very perplexing conditions, but they have been discussed so frequently in print that the public is tolerably well informed in regard to them. If in the government departments the political atmosphere prevents the highest development of scientific life, in the universities the air is chilled, as far as scientific men are concerned, by the widely spread heresy that too much athletics is a good thing for a university. So long as a coach receives a higher salary than any professor, one is warranted in asking whether learning is too cheap or athletics too dear. Certainly on pay day professors would be glad to be classed as coaches. Is the craze for spectacular athletics ever going to pass away? Apparently not, for athletic contests, theatrical and similar non-academic diversions, are naturally more interesting than learning of any kind to a by no means small proportion of those who form the body of students. It is certainly a weak point in our universities that there have to be taken into account two different classes of men; those whose primary object is study and those whose interests are mainly or exclusively athletic and social. It will be said that the line between the two is not a sharp one, but in the interest of learning it seems to me best that a line should be drawn, even if it has to be somewhat arbitrary. One should avoid, in general, making distinctions without differences, but, on the other hand, it should not be forgotten that in some cases the moral effect of making a distinction is to bring out the fact that there is a real difference. It would certainly be advantageous for scientific men, using the word in its broad sense, if the public could be given to understand clearly that in the universities a real distinction is made between the genuine student and the student *pro forma*. They would probably feel that the money they give is well spent if spent on the genuine student, while on the other hand they might be sceptical about the good of spending money on those who do not care to study more than they are forced to do to keep in college. To have it suspected that the universities are of a sort of Jekyl-Hyde nature, at one time all athletics, at another all study, would obscure their true position. It is of great importance that the standard by which the value of a professor is estimated should not be the size of his classes and the number of his lectures. This method of estimating

their value used to be universal and, although the more enlightened part of the public have ceased to regard the number of students and lectures as the most important thing, the old way of estimating values is still far too prevalent. At the present day, the real distinction of a university depends more on the amount and quality of the higher work than on the amount of instruction of a low grade. It was supposed, a few years ago, that the universities and colleges would gradually differentiate themselves into classes; the better endowed into institutions where the higher studies would be made prominent, while those with only a moderate endowment would confine their work to the instruction of undergraduates. But it is not likely that this will be the result. The advent of the multi-millionaire makes it possible that at any time some very rich man may leave his millions to one of the poorly endowed colleges. Since any college may succeed in capturing the millions, there is a new inducement for colleges to live beyond their means rather than limit themselves to what they can do well with the money they actually have. In the universities, as in the government departments, there is a disposition to branch out in too many directions and to believe that one university must try to do everything that other universities are trying to do. Sooner or later there must be some limitation to what any given university can expect to do; otherwise, since the amount of money which even the best endowed universities can expect will never be sufficient for them to do everything, some, if not many, of the branches of science must be kept on a starvation basis. The governing bodies of universities are altogether too much inclined to ask themselves the question, Is there not some new subject which can be introduced? without stopping to consider the more fundamental question whether the subjects already included in the curriculum are properly provided for.

Briefly, the main difficulties to be met with in the universities are, first, as we have seen, the organic connection of a studious and a non-studious body which would be remedied were it possible to draw the line between work of a low grade and the higher studies and place those in charge of the latter in an independent position. Two other difficulties are the excessive demand on the time and energy of the professors by lectures and class work and, in many cases, the insufficiency of the salaries. In a way, the two are phases of the same difficulty. If there were plenty of money both would disappear. Since so large a portion of the income of most universities is derived from students' fees, there is a tendency to pay the larger salaries to those having the larger classes or, at least, those with large classes feel aggrieved that the fees should be spent largely on those in charge of the higher studies in which there must always be a few students. There is, it seems to me, no better way of aiding universities than by endowing chairs in the departments of higher studies in which there can never be many students and where the amount obtained from fees is hardly worth considering.

Perhaps the most important question affecting the future not only of science in the limited sense, but of learning of all kinds in this country, is that of the proper relation of the faculties of the universities to the trustees. That the question has come into prominence at the present time is due to the fact that, since in business the tendency is toward a greater concentration of power in a few hands, so, if we regard education as a business, the control of all educational questions should be in the hands of a few trustees. In the universities, however, there is the purely financial question of the management of the funds and the

question of education considered from the intellectual side, and the two questions are not only essentially different in their nature, but also the training necessary for a business man is not the same as that necessary for one who is to be an educator and a scholar. To the trustees belongs the management of the finances and it would be preposterous to entrust purely business matters to a numerous body like the faculty even were they not unfitted for such work by their lack of proper training. To the faculty belong the practical work of education and the advancement of learning. The difficulty at the present time is that when it comes to the question of the general educational policy to be pursued, there is an increasing tendency on the part of trustees to assume that that is their business and not that of the faculty. Practically the board which controls the expenditure of money can, if it wishes, shape the policy without regard to the opinion of others. Whether it is better for education and learning that they should do so is another matter. Probably a large portion of the educated public are of the opinion that the faculty are better qualified than the trustees to decide educational questions both theoretical and practical, and they would certainly agree in thinking that no educational policy should be adopted without the concurrence of the faculty. It would surely be a misfortune should the public endorse the opinion said to have been expressed recently by a trustee that the faculty are merely the employees of the trustees and that their opinion is of no consequence even in cases which seriously affect their work and their future. Furthermore, the farce of asking the opinion of a faculty when there was never the slightest idea of following it does not add to the dignity of either trustees or faculty nor does it tend to bring about the harmony of action necessary to success. The expression, only an employee, however, may not be quite so contemptuous as it at first seems, for, after all, the trustees themselves are only employees. They are not managing their own money on their own account, but are simply employed to carry out the intentions of those who have given their money to found and carry on different institutions of learning and they are responsible to the public for the way they perform their duties. They may not be paid in money, but they are paid in the honor of holding positions which are justly highly prized. Unless the public feel that they are administering their trusts wisely and in accordance with the intentions of those who have given the money, they will sooner or later cease to supply more funds and there is always need of more money.

It seems to me that the antagonism between the trustees and the faculty is really less marked than many suppose and, if the opinions of the faculty are at times apparently disregarded, it may be in part, at least, because the trustees find it difficult to ascertain just what the collective opinion of the faculty is. In the larger universities the faculties are so large that, when meeting in a body, their discussions are apt to be very prolonged and not always to the point. It ought to be possible to contrive some way in which the views of both boards could be presented in a definite, practical way. In one of our universities, I understand, there is a joint board composed of some trustees and some members of the faculty, known as the committee on education, before which are brought questions in which both boards are intimately concerned, and the recommendations of this committee, it is said, have always, so far as known, been adopted by the trustees. The faculty members of such a board should of course be selected by the faculty itself and serve only for fixed intervals, in order that they may really rep-

resent the views of the majority of the faculty at any given time.

If in discussing the position of scientific men in this country I have given greater prominence to the conditions which tend to retard progress than to those which favor it, it is because I believe that the first step toward the removal of obstacles is to state clearly what those obstacles are. It is not improbable that some evils will disappear as soon as it is generally recognized that they are evils. We have seen that the public are more interested than they were in the welfare of scientific men, and the better they understand existing conditions, the better for us. If they now believe that organization and concentration are necessary in science, as in business, they should also understand that organization has its dangers as well as its advantages. While accepting the prevailing idea of the necessity of organization, we must, at the same time, insist that the future of science requires that a proper balance be maintained between general organization and individual independence. Furthermore, the organization needed in science does not consist in having scientific work placed under the control of purely business men but of scientific men who have a capacity for administration, and such men can be found. Purely financial matters must be entrusted to non-scientific business men, but science itself is something different from business in the ordinary sense. Even when placed in charge of scientific men, it is important to avoid carrying the organization of science so far as to repress individual effort and bring about a sort of bureaucracy which resents unfavorable criticism and requires all work to conform to a fixed narrow standard. Science should be a republic in which, with the approval of the majority of workers, the more capable become the rulers. Science should be well organized, but it should never become, in a purely business sense, a trust.

W. G. Farlow.

Harvard University.

THE PROBLEM OF THE METALLIFEROUS VEINS.[1]

The rush of the gold-seekers to California in 1849, and the quickly following one to Australia in 1851, were notable migrations in search of the yellow metal, but they were not the first in the history of our race. There is, indeed, no reason to suppose that, in the past, mining excitements were limited even to the historical period; on the contrary, the legends of the golden fleece, and of the golden apples of the Hesperides, probably describe in poetic garb two of the early expeditions, and long before either we can well imagine primitive man hurrying to new diggings in order to enlarge his scanty stock of metals. Among the influences which have led to the exploration and settlement of new lands, the desire to find and acquire gold and silver has been one of the most important, and as a means of introducing thousands of vigorous settlers, of their own volition, into uninhabited or uncivilized regions there is no agent which compares with it. In this connection it may be also remarked that there is no more interesting chapter in the history of civilization, than that which concerns itself with the use of the metals and with the development of methods for their extraction from their ores. Primitive man was naturally limited to those which he found in the native state. They are but few, viz., gold in wide but sparse distribution in gravels; copper in occasional masses along the outcrops of veins, in which far the greater part of the metal is combined with oxygen or sulphur, copper again, in porous rocks, as in the altogether exceptional case

[1] Presidential address before the New York Academy of Sciences, December 18, 1905.

of the Lake Superior mines; iron in an occasional meteorite, which, if its fall had been observed, was considered to be the image of a god, descended from the skies;[2] silver in occasional nuggets with the more common ones of gold; and possibly a rare bit of platinum. Besides these no other metal can have been known, because all the rest and all of those mentioned, when locked up in their ores, give in the physical properties of the latter but the slightest suggestion of their presence. Chance discoveries must have first revealed the possibilities of producing iron from its ore—really a very simple process when small quantities are involved; of making bronze from the ores of copper and tin; of making brass with the ores of copper and zinc; of reducing copper and lead from their natural compounds; and of freeing silver from its chief associate, lead. All of these processes were extensively practised under the Chinese, Phenicians, Greeks, Romans and other ancient peoples.

As the need of weapons in war, the advantages of metallic currency and the want of household utensils became felt, and as the minerals which yield the metals became recognized as such, the art of mining grew to be something more than the digging and washing of gravels; and in the long course of time developed into its present stage as one of the most difficult branches of engineering. Chemistry raised metallurgical processes from the art of obtaining *some of a metal* from its ore, to the art of obtaining *almost all* of it and of accounting for what escaped. It is, in fact, in this scientific accounting for everything, that modern processes chiefly differ from those of the ancients.

Of all the metals the most important which minister to the needs of daily life are the following, ranged as nearly as possible in the order of their usefulness: Iron, copper, lead, zinc, silver, gold, tin, aluminum, nickel, platinum, manganese, chromium, quicksilver, antimony, arsenic and cobalt. The others are of very minor importance, although often indispensable for certain restricted uses.

The manner of occurrence of these metals in the earth, and their amounts in ores which admit of practicable working are fundamental facts in all our industrial development, and some accurate knowledge of them ought to be a part of the intellectual equipment of every well-educated man. The matter may well appeal to Americans, since the United States have developed within a few years into the foremost producers of iron, copper, lead, coal, and until recent years of gold and silver; but with regard to gold, they have of late alternated in the leadership with the Transvaal and Australia, and in silver are now second to Mexico.

Despite the enormous product of foodstuffs, American mining developments are of the same order of magnitude; and the mineral resources of the country have proved to be one of the richest possessions of its people.

We may best gain a proper conception of the problem of the metalliferous veins, if we state at the outset the gross composition of the outer portion of the globe, so far as geologists have been able to express it by grouping analyses of rocks. We may then note among the elements mentioned, such of the metals as have just been cited and may remark the rarity of the others; we may next set forth the necessary percentages of each metal which make a deposit an ore, that is, make it rich enough for profitable working. By comparison we can grasp in a general way the amount of concentration which must be accomplished by the geological agents in order to collect from a naturally lean distribution in rocks

[2] As in the case of Diana of the Ephesians and the deity of the Carthaginians.

enough of a given metal to produce a deposit of ore; and can then naturally pass to a brief discussion and description of those agents and their operations.

If the general composition of the crust of the earth is calculated as closely as possible on the basis of known chemical analyses, the following table results, which has been compiled by Dr. F. W. Clarke, of Washington, chief chemist of the U. S. Geological Survey.[3]

Oxygen	47.13
Silicon	27.89
Aluminum	8.13
Iron	4.71
Calcium	3.53
Magnesium	2.64
Potassium	2.35
Sodium	2.68
Titanium	.32
Hydrogen	.17
Carbon	.13
Phosphorus	.09
Manganese	.07
Sulphur	.06
Barium	.04
Chromium	.01
Nickel	.01
Strontium	.01
Lithium	.01
Chlorine	.01
Fluorine	.01
Total	100.00

Elements less than .01 per cent. are not considered abundant enough to affect the total, and equally exact data regarding them are not accessible. Among those given only the following appear which are metals of importance as such in every-day life: aluminum 8.13, iron 4.71, manganese .07, chromium .01 and nickel .01. They rank, respectively, in the table, third, fourth, thirteenth, sixteenth and seventeenth. Of the five, iron is the only one of marked prominence. No one of the remaining four is comparable in usefulness with at least five other metals which are not mentioned, viz., copper, lead, zinc, silver and gold.

An endeavor has been made by at least one investigator, Professor J. H. L. Vogt, of Christiania, to establish some quantitative expression for these other metals. His estimates are as follows:[4]

Copper percentage beyond the fourth or fifth place of decimals, that is, in the hundred thousandths or millionths of a per cent.

Lead and zinc, percentages in the fifth place of decimals or in the hundred thousandths of a per cent.

Silver, percentage, two decimal places beyond copper—or in the ten millionths to the hundred millionths of a per cent., or the ten thousandth to the hundred thousandth of an ounce to the ton.

Gold, percentage, one tenth as much as silver.

Tin, percentage in the fourth or fifth decimal place, that is, in the ten thousandths or hundred thousandths of a per cent.

These figures, inconceivably small as they are, convey some idea of the rarity of these metals as constituents on the average of the outer six or eight miles of the earth's crust. But they are locally more abundant in particular masses of eruptive rocks which are associated with ore deposits.

In the following tabulation I have endeavored to bring together a number of determinations which have been made in connection with investigations of American mining districts. In a general way they give a fair idea of the metallic contents of certain eruptive rocks from which were taken samples as little as possible open to the suspicion that they had been enriched by the same processes which had produced the neighboring ore-bodies.

In order to come within the possible limits of profitable and successful treat-

[3] Bulletin 148, p. 13.

[4] *Zeitschrift für prak. Geologie*, 1898, 324.

	Per Cent. in Eruptive Rocks.	From.
Copper,	.009	Missouri.[5]
Lead,	.0011	Colorado.[6]
Lead,	.008	Eureka, Nev.[7]
Lead,	.004	Missouri.[5]
Zinc,	.0048	Leadville, Colo.[8]
Zinc,	.009	Missouri.[5]
Silver,	.00007	Leadville, Colo.[9]
Silver,	.00016	Eureka, Nev.[7]
Silver,	.00016	Rosita, Colo.[10]
Gold,	.00002	Eureka, Nev.[7]
Gold,	.00004	Owyhee Co.,[11] Id.

ment the ores of the more important metals should have at least the above percentages, but that we may grasp the relations correctly, it must be appreciated that local conditions affect the limits. Thus in a remote situation and with high charges for transportation an ore may be outside profitable treatment, although it may contain several times the percentages of those more favorably situated. Iron ores in particular which are distant from centers of population, are valueless unless cheap transportation on a very large scale can be developed, while gold in an almost inaccessible region, like the Klondike, may yield a rich reward, even when in quantities which, if expressed in percentages, are almost inappreciable.

The nature of the ore is also a factor of prime importance. Some compounds yield the metals readily and cheaply, while others, which in the case of the precious metals are often called base ores, require complicated and it may be expensive metallurgical treatment. The association of metals is likewise of the highest importance. Copper or lead, for example, greatly facilitates the extraction of gold and silver, whereas zinc in large quantities is a hindrance. Conditions also change. An ore which may have been valueless in early days may prove a rich source of profit in later years and under improved conditions. For instance, from 1870 for over twenty-five years Bingham Canyon in Utah yielded lead-silver ores and minor deposits of gold. It was known that in some mines low-grade and base ores of copper and gold existed, but the fact was carefully concealed and in at least one instance the shaft into them was filled up, lest a general knowledge of the fact should unfavorably affect the value of the property. To-day, however, these ores are eagerly sought and their extraction and treatment in thousands of tons daily are paying good returns on very large capitalization. Another factor is the expense of extraction. If simple and inexpensive methods are possible, the area of profitable treatment is greatly widened. Thus gold may need little else than a stream of water or even a blast of air, whereas iron and copper require huge furnaces and vast supplies of coke and fluxes.

Iron ores are of little value in any part of the world unless they contain a minimum of 35 per cent. iron when they enter the furnace, but if they are distributed in amounts of 10–20 per cent., in extensive masses of loose or easily crushed rock in such condition that they can be cheaply concentrated up to rich percentages, they may be profitably treated and a product with 50 per cent. iron or higher be sent to the furnaces. Nevertheless, speaking for the civilized world at large, it holds true that as an iron ore enters the furnace, it can not have less than 35 per cent., and in

[5] Average of eight eruptives from Missouri, Anals. by J. D. Robertson. Report on Lead and Zinc, Mo. Geol. Surv., II., 479.

[6] Average of six different rocks, embracing eighteen assays; S. F. Emmons, Monograph XII., U. S. Geol. Surv., 591.

[7] One rock, a quartz porphyry, not certain the rock was not enriched. J. D. Curtis, U. S. Geol. Surv., Mono. VII., 136.

[8] Same reference as under 6. The zinc was determined in but two samples.

[9] Same reference as under 6, but p. 594.

[10] S. F. Emmons, XVII. Ann. Rep. U. S. Geol. Survey, Part II., p. 471.

[11] A. Simundi in Tenth Census, XIII., 54.

America with our rich and pure deposits on Lake Superior two thirds of our supply ranges from 60–65 per cent.

As regards copper, a minimum working percentage, amid favorable conditions and with enormous quantities, is usually about 3 per cent., but in the altogether exceptional deposits of the native metal in the Lake Superior region, copper-rock as low as three fourths of one per cent. has been profitably treated. This or any similar result could only be accomplished with exceptionally efficient management and with a copper rock such as is practically only known on Lake Superior. With the usual type of ore, not enriched by gold or silver, two per cent. is the extreme and in remote localities five to ten may sometimes be too poor.

In southeast Missouri, lead ores are profitably mined which have 5–10 per cent. lead, but they are concentrated to 65–70 per cent. before going to the furnace.

Zinc ores at the furnace ought not to yield less than 25–30 per cent., and when concentrated or selected they range up to 60 per cent.

The precious metals are expressed in troy ounces to the ton avoirdupois. A troy ounce in a ton is one three-hundredths of one per cent., and the amount is, therefore, very small when stated in percentages. If it be appreciated that in round numbers silver is now worth fifty to sixty cents an ounce and gold twenty dollars, some grasp may be had of values. Silver rarely occurs by itself. On the contrary, it is obtained in association with lead and copper, and the ores are, as a rule, treated primarily for these base metals, and then from the latter the precious metals are later separated. In the base ores there ought to be enough silver to yield a minimum of five dollars or ten ounces in the resulting ton of copper in order to afford enough to pay for separation. Now in a five per cent. ore of copper we have a concentration of twenty tons of ore to yield one ton of pig, or, more correctly stated, so as to allow for losses, twenty-one tons to one. We must, therefore, have at least ten ounces of silver in the twenty-one tons, which implies a minimum of about one half ounce per ton. Smelters will only pay a miner for the silver if he has over one half ounce per ton in a copper ore. In a pig of lead, usually called base bullion, it is necessary for profitable extraction to have fifteen ounces of silver. For smelting a lead ore we must possess at least ten per cent. lead and may have seventy. It is, therefore, obvious that from two to twenty ounces silver must be present in the ton of lead ore. The common ranges are ten to fifty ounces or one thirtieth to one sixth of one per cent.

Gold is so cheaply extracted that it may be profitably obtained under favorable circumstances down to one tenth of an ounce in the ton, but the run of ores is from one fourth ounce or five dollars to one ounce or twenty dollars. Ores of course sometimes reach a number of ounces. In copper or lead ores even a twentieth of an ounce may be an object and in favorably situated gravels, to which the hydraulic method may be applied, even as little as seven to ten cents in the cubic yard may be recovered or some such value as one two-hundredths to one three-hundredths of an ounce per ton.

The tin ores as smelted contain about 70 per cent., but they are all concentrated either by washing gravels in which the percentage is one or less or else by mining, crushing and dressing ore in which it ranges from 1.5 to 3 per cent. The tin-bearing gravels represent a concentration from much leaner dissemination in the parent veins and granite. Aluminum ores yield as sold about 30 per cent. of the metal. This is an enrichment as compared

with the rocks, though not so striking a one as in the case of other metals. But the great change necessary in aluminum is in the method of combination. It is so tightly locked up in silicates in the rocks as to preclude direct extraction by any known method.

Nickel needs to be present in amounts of several per cent., say two to five, and occurs either alone or with copper. Cobalt is always with it in small amounts. Platinum occurs in exceedingly small percentages. It is almost all obtained from gravels in Russia, and the gravels yielded in 1899, according to C. W. Purington, about forty cents to the yard, platinum being quoted in that year at $15 to $18 per ounce. There was, therefore, in the gravels about one fortieth ounce in the yard, or one sixtieth in a ton or about 5.5 hundred-thousandths of a per cent. Platinum in some rocks has been found in amounts of one twentieth to one half ounce, or from 16 hundred-thousandths to 16 ten-thousandths of one per cent., but they are rare and peculiar types.

In order to be salable manganese ores of themselves must yield about 50 per cent., but if iron is also present they may be as low as 40. Chromium has but one ore, and it must contain about 40 per cent. Of antimony, arsenic and cobalt it is hardly possible to speak, since, except perhaps in the case of the first, they are unimportant by-products in the metallurgy of other ores.

In summary it may be stated that in the ores the metals must be present in amounts shown in accompanying table.

We now have before us some fundamental conceptions from which as a point of departure we may set out upon the real discussion of the subject. We understand the gross composition of the outer earth; we have some idea of the quantitative distribution of the metals in the rocks, especially in the richer instances; finally we have

	Percentages in Ores.	Ounces to Ton.	Percentage in the Earth's Crust.
Iron,	35–65		4.71
Copper,	2–10		.0000X
Lead,	7–50		.0000X
Zinc,	25–60		.0000X
Silver,	1/12–1/150	2–25	.000000X
Gold,	1/300–1/6,000	1/20–1	.0000000X
Tin,	1–3		.000X-.0000X
Aluminum,	30		8.13
Nickel,	2–5		.01
Manganese,	50		.07
Chromium,	40		.01

seen the extent to which they must be concentrated in order that they may be objects of mining. The next step is to establish first the agent or solvent which can effect the collection of the sparsely distributed metals, and second the places where the precipitation of them takes place. We may then inquire more particularly into the source of the agent and the methods of its operation. In order to do this in the time at command I must remorselessly focus attention on the large and essential features, resolutely avoiding every side issue or minor point, however inviting.

The one solvent which is sufficiently abundant is water, and practically all observers are agreed that for the vast majority of ore deposits it has been the vehicle of concentration. Of course it need not operate alone. On the contrary, easily dissolved and ever-present materials like alkalies may, and undoubtedly do, increase its efficiency. It does not operate necessarily as cold water. On the contrary, we all know that the earth grows hotter as we go down, so that descending waters could not go far without feeling this influence. Volcanoes, too, indicate to us that there are localities where heat is developed in enormous amounts and not far below the surface. There is, therefore, no lack of heat and we only need to be familiar with the western country to know that there is no lack of hot springs when we take a compre-

hensive view. As solvents, hot waters are so incomparably superior to cold waters that they appeal to us strongly. We may, therefore, take it as well established that water is the vehicle. The chemical compounds which constitute the ores naturally differ widely in solubility and no sweeping statements can be made regarding them. Iron, for example, yields very soluble salts and is widely, one might almost say universally distributed in ordinary waters. Its ores are compounds of the metal with oxygen, and in this respect it differs from nearly all others, which are mostly combined with sulphur. Although almost all of them have oxidized compounds, the latter are on the whole very subordinate contributors to our furnaces.

Iron is everywhere present in the rocks and when exposed to the natural reagents it is one of their most vulnerable elements. It, therefore, presents few difficulties in the way of solution and concentration by waters which circulate on or near the surface and which perform their reactions under our eyes.

The compounds of copper, lead, zinc, silver, nickel, cobalt, quicksilver, antimony and arsenic with sulphur present more difficult problems and ones into whose chemistry it is impossible to enter here in any thorough way, but in general it may be said that the solutions were probably hot, that they were in some cases alkaline, in others acid, and that the pressure under which they took up the metals in the depths has been an important factor in the process. The loss of heat and pressure as they rose toward the surface no doubt aided in an important way in the result.

The first condition for the production of an ore-deposit is a waterway. It may be a small crack, or a large fracture, or a porous stratum, but in some such form it must exist. Naturally porous rock affords the simplest case, and provides an easily understood place of precipitation. For example, in the decade of the seventies rather large mines at Silver Reef, in southern Utah, were based upon an open-textured sandstone into which and along certain lines silver-bearing solutions had entered. Wherever they met a fossil leaf or an old stick of wood which had been buried in the rock the dissolved silver was precipitated as sulphide or chloride. Sometimes for no apparent reason the solutions impregnated the rock with ore, but the ore seems to follow along certain lines of fracturing. Again at Silver Cliff near Rosita in central Colorado, the silver solutions had evidently at one time soaked through a bed of porous volcanic ash, and had impregnated it with ore, which, while it lasted, was quarried out like so much rock. In the copper district of Keweenaw Point on Lake Superior, the copper bearing solutions have penetrated in some places an old gravel bed and impregnated it with copper; in other places they have passed along certain courses in vesicular lava flows, and have yielded up to the cavities, scales and shots of native copper.

It has happened at times that the ore-bearing solutions, rising through some crevice, have met a stratum charged with lime, and having spread sideways have apparently been robbed of their metals because the lime precipitated the valuable minerals. In the Black Hills of South Dakota, there are sandstones with beds of calcareous mud rocks in them. Solutions bringing gold have come up through insignificant-looking crevices called 'verticals' and have impregnated these mud-rocks with long shoots of valuable gold ores. In prospecting in a promising locality the miner, knowing the systematic arrangement of the verticals, and having found the lime shales, drifts along in them, following a crevice in the hope of breaking

into ore. The very extended and productive shoots of lead-silver ores at Leadville, Colo., which have been vigorously and continuously mined since 1877, are found in limestone and usually just underneath sheets of a relatively impervious eruptive rock. They run for long distances and suggest uprising solutions which followed along beneath the eruptive, perhaps checked by it, so that they have replaced the limestone with ore. The limestone must have been a vigorous precipitant of the metallic minerals.

The fracture itself up through which the waters rise may be of considerable size and thus furnish a resting place for the ore and gangue, as the associated barren mineral is called. A deposit then results which affords a typical fissure vein. The commonest filling is quartz, but at times a large variety of minerals may be present and sometimes in beautifully symmetrical arrangement. In the latter case the uprising waters have first coated each wall with a layer. They have then changed in composition and have deposited a later and different one, and so on until the crack has become filled. Often cavities are left at the center or sides and are lined with beautiful and shining crystals, which flash and sparkle in the rays of a lamp, like so many gems. There are quartz veins in California which are mined for gold and which seem to have filled clean-cut crevices, wall to wall, for several feet across. More often there is evidence of decided chemical action upon the walls, which may be impregnated with the ore and gangue for some distance away from the fissure. As the source of supply is left, however, the impregnation becomes less and less rich, and finally fades out into barren wall-rock. The enrichment of the walls varies also from point to point, since where the rock is tight the solutions can not spread laterally, but where it is open the impregnation may be extensive. The miner has, therefore, to allow for swells and pinches in his ore.

Of even greater significance than the lateral enrichment is the peculiar arrangement of the valuable ore in a vein that may itself be continuous for long distances although in most places too barren for mining. Cases are, indeed, known in which profitable vein matter may be taken out continuously for perhaps a mile along the strike, but they are relatively rare. The usual experience reveals the ore running diagonally down in the vein filling, and more often than not following the polished grooves in the walls which are called slickensides, and which indicate the direction taken by one wall when it moved on the other during the formation of the fracture. The rich places may terminate in depth as well, and again may be repeated, but they must be anticipated, and for them allowance must be made in any mining operation.

Ores, therefore, gather along subterranean waterways. They may fill clean-cut fissures, wall to wall; they may impregnate porous wall rocks on either side, they may even entirely replace soluble rocks like limestones.

We may now raise the question as to the source of the water which accomplishes these results and the further question as to the cause of its circulations.

The nature of the underground waters which are instrumental in filling the veins, presents one of the most interesting, if not the most interesting, phase of the problem and one upon which attention has been especially concentrated in later years. The crucial point of the discussion relates to the relative importance of the two kinds of ground-waters, the magmatic, or those from the molten igneous rocks, and the meteoric or those derived from the rains. The magmatic waters are not phenomena

of the daily life and observation of the great majority of civilized peoples, and for this reason they have not received the attention that otherwise would have fallen to their share. Relatively few geologists have the opportunity to view volcanoes in active eruption, and have but disproportionate conceptions of the clouds and clouds of watery vapor which they emit. The enormous volume has, however, been brought home to us in recent years, with great force, by the outbreak of Mont Pelée, and we of this academy, thanks to the efforts of our fellow-member, Dr. E. O. Hovey, of the American Museum of Natural History, have had them placed very vividly before us. It is on the whole not surprising that to the meteoric waters most observers in the past have turned for the chief, if not the only, agent. I will, therefore, first present as fully as the time admits, and as fairly as I may, this older view which still has perhaps the largest number of adherents.

Except in the arid districts, rain falls more or less copiously upon the surface of the earth. The largest portion of it runs off in the rivers; the smallest portion evaporates while on the surface, and the intermediate part sinks into the ground, urged on by gravity, and joins the ground-waters. Where crevices of considerable cross-section exist, they conduct the water below in relatively large quantity. Shattered or porous rock will do the same and we know that open-textured sandstones dipping down from their outcrops and flattening in depth lead water to artesian reservoirs in vast quantity. As passages and crevices grow smaller, the friction on the walls increases and the water moves with greater and greater difficulty. When the passage grows very small, movement practically ceases. The flow of water through pipes is a very old matter of investigation, and all engineers who deal with problems of water supply for cities or with the circulation of water for any of its countless applications in daily life must be familiar with its laws. Friction is such an important factor that only by the larger natural crevices can the meteoric waters move downward in any important quantity or with appreciable velocity. They do sink, of course, and come to comparative rest at greater or less distance from the surface and yield the supplies of underground water upon which we draw.

The section of the rocks which stands between the surface and the groundwater is the arena of active change and is that part of the earth's crust in which the meteoric waters exercise their greatest effect. Rocks within this zone are in constant process of decay and disintegration. Oxidation, involving the production of sulphuric acid from the natural metallic sulphides, is actively in progress. Carbonic acid enters also with the meteoric waters. The rocks are open in texture and favorably situated for maximum change. From this zone we can well imagine that all the finely divided metallic particles which are widely and sparsely distributed in the rocks go into solution and tend to migrate downward into the quiet and relatively motionless ground-water. If the acid solutions escape the precipitating action of some alkaline reagent such as limestone they may even reach the ground-waters, and their dissolved burdens may be contributed to this reservoir, but the greater portion seems to be deposited at the level of the ground-water itself or at moderate distances below it. Impressed by these phenomena which present a true cause of solution, and influenced by their familiar and every-day character, we may build up on the basis of them a general conception of the source of the metallic minerals dissolved in those aqueous solutions which are

recognized by all to be the agents for the filling of the veins.

Let us now focus attention on the ground-water. This saturates the rocks, fills the crevices and forces the miner who sinks his shaft, to pump, much against his natural inclination. The vast majority of mines are of no great depth, and the natural conclusion of our earlier observers, based on this experience, has been that the ground-waters extend downward, saturating the strata of the earth to the limit of possible cavities, distances which vary from 1,000 to more than 30,000 feet. To this must be added another familiar phenomenon. The interior temperature of the earth increases at a fairly definite ratio of about one degree Fahrenheit for each 60–100 feet of descent. In round numbers, if we start with a place of the climatic conditions of New York—that is, with a mean annual temperature of about 51°, we should on descending 10,000 feet below the surface find a temperature of about 212°, and if we go still deeper, it would be still greater. Of course, under the burden of the overlying column of water, the actual boiling points for the several depths would be greater, and it is a question whether the increase of temperature would overcome the increase of pressure and the consequent rise of the boiling point so as to convert this water into steam, cause great increase in its elasticity, decrease in its specific gravity and thereby promote circulations. At all events, the rise in temperature would cause expansion of the liquid, would disturb equilibrium and to this degree would promote circulations.

There is one other possible motive power. The meteoric waters enter the rocky strata of the globe at elevated points, sink downward, meet the ground-water at altitudes above the neighboring valleys and establish thereby what we call head. In consequence they often yield springs. If we imagine the head to be effective to considerable depths we have again the deep-seated waters under pressure, which after their long and devious journey through the rocks may cause them to rise eleswhere as springs. The head may in small degree be aided by the expansion of the uprising heated column, whose specific gravity is thereby lowered as compared with the descending colder column.

May we now draw all these facts and supposed or assumed phenomena into one whole?

The descending meteoric waters become charged with dissolved earthy and metallic minerals in their downward, their deep-seated lateral and perhaps also at the beginning of their heated uprising journey. They are urged on by the head of the longer and colder descending column and by the interior heat. They gather together from many smaller channels into larger issuing trunk channels. They rise from regions of heat and pressure which favor solution, into colder regions of precipitation and crystallization. They deposit in these upper zones their burden of dissolved metallic and earthy minerals and yield thus the veins from which the miner draws his ore.

This conception is based on phenomena of which the greater part are the results of every-day experience. It is attractive, reasonable and is on the whole the one which has been most trusted in the past. Doubtless it has the widest circle of adherents to-day. It is, however, open to certain grave objections which are gaining slow but certain support.

The conception of the extent of the ground-water in depth, for example, is flatly opposed to our experience in those hitherto few but yearly increasing deep mines which go below 1,500 or 2,000 feet. Wherever deep shafts are located in regions other than those of expiring but not dead

volcanic action, they have passed *through* the ground-water, and if this is carefully impounded in the upper levels of the mines and not allowed to follow the workings downward, it is found that there is not only less and less water, but that the deep levels are often dry and dusty. Along this line of investigation, Mr. John W. Finch, recently the State Geologist of Colorado, has reached the conclusion, after wide experience with deep mines, that the ground-waters are limited, in the usual experience, to about 1,000 feet from the surface and that only the upper layer of this is in motion and available for springs.

Artesian wells do extend in many cases to depths much greater than this and bring supplies of water to the surface, but their very existence implies waters impounded and in a state of rest.

To this objection that the ground-waters are shallow it has been replied that when the veins were being formed the rocks were open-textured and admitted of circulation, but subsequently the cavities and waterways became plugged by the deposition of minerals by a process technically called cementation, and the supply being cut off, they now appear dry. There must, however, in order to make 'the head' effective have once been a continuous column of water which introduced the materials for cementation. It is at least difficult to understand how a process, which could only progress by the introduction of material in very dilute solution, should by the agency of crystallization drive out the only means of its production. Some residue of water must necessarily remain locked up in the partially cemented rock. This residue we, of course, do not find where rocks are dry and drifts are dusty. In many cases also where deep cross-cuts have penetrated the fresh wall-rock of mines, cementation if present has been so slight as to escape detection.

If we once admit that this conclusion is well based, it removes the very foundation from beneath the conception of the meteoric waters and tumbles the whole structure in a heap of ruins.

While I would not wish to positively make so sweeping a statement as this about a question involving so many uncertainties, there is nevertheless a growing conviction among a not inconsiderable group of geologists that the rocky crust of the earth is much tighter and less open to the passage of descending waters than has been generally believed; and that the phenomena of springs which have so much influenced conclusions in the past, affect only a comparatively shallow overlying section. Such phenomena of cementation as we see are probably in large part due to the action of water stored up by the sediments when originally deposited and carried down by them with burial. Under pressure a relatively small amount of water may be an important vehicle for recrystallization.

It has been assumed in the above presentation of the case of the meteoric waters that they are able to leach out of the deep-seated wall rocks the finely disseminated particles of the metallic minerals, but the conviction has been growing in my own mind that we have been inclined to overrate the probability of this action in our discussions. In the first place our knowledge of the presence of the metals in the rocks themselves is based upon the assay of samples almost always gathered from exposures in mining districts. The rock has been sought in as fresh and unaltered a condition as possible and endeavors have been made to guard against the possible introduction of the metallic contents by those same waters which have filled the neighboring veins. But if we admit or assume that the assay values are original in the rock; and, in case the latter is igneous, if we believe that the metallic minerals have crys-

tallized out with the other bases from the molten magma, we are yet confronted with the fact that their very presence and detection in the rock show that they have escaped leaching even though they occur in a district where underground circulations have been especially active. From the results which we have in hand, it is quite as justifiable to argue that the metals in the rocks are proof against the leaching action of underground circulations as that they fall victims to it. These considerations tend to restrict the activities of the meteoric waters to the vadose region as Posepny calls it, *i. e.,* that belt of the rocks which stands between the permanent water-level and the surface. Within it is an active area of solution, as we have all recognized for many years, but, as previously stated, experience shows that the metals which go into solution in it strongly tend to reprecipitate at or not far below the water-level itself.

It is of interest, however, to seek some quantitative expression of the problem and the assays given above furnish the necessary data.

I have taken the values of the several metals which have been found by the assays of what were in most cases believed to be normal wall rocks, selecting those of igneous nature because experience shows them to be the richest. The percentages have been turned into pounds of the metal per ton of rock; this latter value has then been recast into pounds of the most probable natural compound or mineral in each case. I have next calculated the volume of a cube corresponding to the last weight, and by extracting its cube root have found the length of the edge of such cube. If now we assume a rock of a specific gravity of 2.70, which is a fair average value, and allow it 11 to 12 cubic feet to the ton, or say 20,000 cubic inches, the edge of the cube-ton will be 27.14 inches. The ratio of the edge of the cube of metallic mineral to the edge of the cube-ton of enclosing rock, will give us an idea of the chance that a crack large enough to form a solution-water-way will have of intersecting that amount of contained metallic mineral. Of course in endeavoring to establish this quantitative conception I realize that the metallic mineral is not in one cube, and that through a cube-ton of rock more than one crack passes, but I assume that the fineness of division of the metallic mineral practically keeps pace with the lessening width and close spacing of the crevices. It is also realized that the shape of the minerals is not cubical. I am convinced from microscopic study of rocks and the small size of the metallic particles that their subdivision certainly keeps pace with any conceivable solution-cracks, and that no great error is involved in the first assumption made. The sides of a cube represent three planes which intersect at right angles and which are mathematically equivalent to any series of planes intersecting at oblique angles. Hence if we consider as cubes the subdivisions formed in our rock mass by any series of intersecting cracks, there are three sets of planes, any one of which might intersect the cube of ore. We must, therefore, multiply the ratio of probability that any single set will intersect it by three in order to have the correct expression. The chance, therefore, that a crack, of the width of the cubic edge of the enclosed mineral, will strike that cube is given by the ratios in the last column, which ratios I assume hold good with increasing fineness of subdivision both of metallic minerals and of cracks.

From the table it is evident that the chances vary from a maximum in the case of copper of one in six through various intermediate values to a minimum for gold of one in over one hundred. This is equivalent to saying that with cracks

	Per Cent. by Analysis.	Pounds Per Ton.	Pounds Chalcopyrite.	Volume Cu. In.	Edge of Cube.	Ratio of Edge to Edge of Cube-ton Rock.	Ratio of Probability.
Copper.	.009	.18	.52	3.42	1.5	1/18	1/6
			Galena.				
Lead.	.0011	.022	.025	.092	.45	1/60	1/20
	.008	.16	.186	.700	.89	1/31	1/10
	.004	.08	.092	.340	.70	1/39	1/13
			Zincblende.				
Zinc.	.0048	.096	.128	.90	.97	1/35	1/12
	.009	.180	.240	1.60	1.17	1/21	1/7
			Argentite.				
Silver.	.00007	.0014	.0016	.006	.18	1/148	1/49
	.00016	.0032	.0037	.014	.24	1/113	1/38
			Gold.				
Gold.	.00002	.0004	.0004	.00065	.086	1/313	1/101
	.00004	.0008	.0008	.00130	.109	1/249	1/83

whose width bears the same relation to the width of the rock mass as is borne by the diameter of the particle of ore, the chance of crossing a particle varies from one in six to one in one hundred. Or we may say that with cracks of this spacing from one sixth to one one-hundredth of the contained metallic mineral might be leached out.[12] When, therefore, as is often the case in monographs upon the geology of a mining district, inferences are drawn as to the possibility of deriving the ore of a vein by the leaching of wall-rocks whose metallic contents have been proved by assay, the total available contents ought to be divided by a number from six to one hundred if the above reasoning is correct. This diminution will tend to modify in an important manner our belief in the probability of such processes as have been hitherto advocated. We may justly raise the following questions. How closely set, as a matter of fact, are the cracks which are large enough to furnish solution waterways in the above rocks, and can we reach any definite conception regarding their distribution? Some quantitative idea of the relations may be obtained from the tests of the recorded absorptive capacity of the igneous rocks which are employed as building stone. G. P. Merrill in his valuable work on 'Stones for Building and Decoration,' pp. 459, has given these values for 33 granites and 4 diabases and gabbros. They vary for the granites from a maximum of one twentieth to a minimum of one seven-hundred-and-fourth. I have averaged them all and have obtained one two-hundred-and-thirty-seventh as the result. That is, if we take a cubic inch of granite and thoroughly dry it, it will absorb water up to one two hundred and thirty-seventh of its weight. The volume of this water indicates the open spaces or voids in the stone. The average of the specific gravities of the 33 granites is 2.647. If, by the aid of this value we turn our weight of water into volume we find that its volume is one ninetieth that of the rock. For the four diabases and gabbros, similarly treated, the ratio of absorption is one three-hundred-and-tenth; the specific gravity is 2.776 and the ratio of volume one one-hundred-and-tenth. We can express all this more intelligibly by saying that, if we assume a cube of granite and if we combine all its cavities into one crack passing through it, parallel to one of its sides, the width of the crack will be to the edge of the cube, as 1 to 90. In the diabases and gabbros, similarly treated, the ratio will be 1 to 110. These values are very nearly the same as the average of the ratios of the edges of the cubes of rock and ore given in the table above, it being 1 to 104. We may conclude, therefore, that in so far as we can check the previous conclusion by experimental data, it is not far from the truth.

[12] With regard to the flow of waters through crevices and the relation of the flow to varying diameters or widths a very lucid statement will be found in President C. R. Van Hise's valuable paper in the *Transactions of the American Institute of Mining Engineers*, XXX., 41, and in his Monograph on Metamorphism.

It may be stated that the porphyritic igneous rocks which have furnished nearly all the samples for the above analyses, are as a rule extremely dense, and that their absorptive capacity is more nearly that of the compact granites than the open textured ones. It is highly improbable that underground water circulates through these rocks to any appreciable degree except along cracks which have been produced in the mechanical way, either by contraction in cooling and crystallizing, or by faulting and earth movements. The cracks from faulting are very limited in extent and in the greater number of our mining districts affect but narrow belts, small fractions of the total. Of the cracks from cooling and crystallizing those of us who have seen rock faces in cross-cuts and drifts underground, where excavations have been driven away from the veins proper, can form some idea, if we eliminate the shattering due to blasting. My own impression is that in rocks a thousand feet or so below the surface they are rather widely spaced, and that, when checked in a general way by the ratios just given, they are decidedly unfavorable materials from which the slowly moving meteoric groundwaters (if such exist) may extract such limited and finely distributed contents of the metals.

I have also endeavored to check the conclusions by the recorded experience in cyaniding gold ores in which fine crushing is so important, and I can not resist the conviction that we have been inclined to believe the leaching of compact and subterranean masses of rock a much easier and more probable process than the attainable data warrant.

As soon, however, as we deal with the open-textured fragmental sediments and volcanic tuffs and breccias the permeability is so enhanced as to make their leaching a comparatively simple matter. Yet so far as the available data go, they are poor in the metals or else are open to the suspicion of secondary impregnation. They certainly have been seldom, if ever, selected by students of mining regions as the probable source of the metals in the veins.

Should the above objections to the efficiency of the meteoric waters seem to be well established, or at least to have weight, it follows that the arena where they are most, if not chiefly, effective is the vadose region, between the surface and the level of the ground-water. Undoubtedly from this section they take the metals into solution and carry them down. But it is equally true that they lose a large part of this burden, especially in the case of copper, lead and zinc, at or near the level of the ground-water and are particularly efficient in the secondary enrichment of already formed but comparatively lean orebodies.

Let us now turn to the magmatic waters. That the floods of lava which reach the surface are heavily charged with them, there is no doubt. So heavily charged are they, that Professor Edouard Suess, of Vienna, and our fellow member, Professor Robert T. Hill, of New York, have seen reason for the conclusion that even the oceanic waters have in the earlier stages of the earth's history been derived from volcanoes rather than, in accordance with the old belief, volcanoes derive their steam from downward percolating sea-water. From vents like Mont Pelée which in periods of explosive outbreaks yield no molten lava, the vapors rise in such volume that cubic miles become our standards of measurement.

There is no reason to believe that many of the igneous rocks which do not reach the surface are any less rich and when they rise so near to the upper world that their emission may attain the surface, we must assign to the emitted waters a

very important part in the underground economy.

This general question has attracted more attention in Europe in recent years as regards hot springs than in America. So many health resorts and watering-places are located upon them that they are very important foundations of local institutions and profitable enterprises. Professor Suess, whom I have earlier cited, delivered an address a few years ago at an anniversary celebration in Carlsbad, Bohemia, in which he maintained that in the Carlsbad district the natural catchment basin was insufficient to supply the waters and that both the unvarying composition and amount through wet seasons and dry were opposed to a meteoric source. Water, therefore, from subterranean igneous rocks, well-known to exist in the locality, was believed to be the source of the springs. The same general line of investigation has led Dr. Rudolf Delkeskamp, of Giessen, and other observers to similar conclusions for additional springs, so that magmatic waters have assumed a prominence in this respect which leaves little doubt as to their actual development and importance.

All familiar with western and southwestern mining regions know as a matter of experience, that the metalliferous veins are almost always associated with intrusive rocks, and that in very many cases the period of ore formation can be shown to have followed hard upon the entrance of the eruptive. The conclusion has, therefore, been natural and inevitable that the magmatic waters have been, if not the sole vehicle of introduction, yet the preponderating one.

With regard to their emission from the cooling and crystallizing mass of molten material we are not, perhaps, entirely clear or well established in our thought. So long as the mass is at high temperatures the water is potentially present as dissociated hydrogen and oxygen. We are not well informed as to just what is the chemical behavior of these gases with regard to the elements of the metallic minerals. Hydrochloric acid gas is certainly a widely distributed associate. If, as seems probable, these gases can serve alone or with other elements as vehicles for the removal of the constituents of the ores and the gangue, the possibilities of ubiquitous egress are best while the igneous rock is entirely or largely molten. In part even the phenomena of crystallization of the rock-forming minerals themselves may be occasioned by the loss of the dissolved gases. Through molten and still fluid rock the gases might bubble outward if the pressure were insufficient to restrain them and would, were their chemical powers sufficient, have opportunity to take up even sparsely distributed metals.

On the other hand, if their emission as seems more probable, is in largest part a function of the stage of solidification and takes place gradually while the mass is congealing, or soon thereafter, then they must depart along crevices and openings whose ratio to the entire mass would be similar to those given above. They might have, and probably do have, an enhanced ability to dissolve out in a searching and thorough manner the finely distributed metallic particles as compared with relatively cold meteoric waters which might later permeate the rock; but as regards the problem of leaching, the general relations of crevices to mass are much the same for both, and it holds also true that the discovery of the metals by assay of igneous rocks proves that all the original contents have not been taken, by either process.

We may, however, consider an igneous mass of rock as the source of the water even if not of the ores and gangue, and then we have a well-established reservoir

for this solvent in a highly heated condition and at the necessary depths within the earth. Both from its parent mass and from the overlying rocks traversed by it, it may take the metals and gangue.

In the upward and especially in the closing journey, meteoric waters may mingle with the magmatic, and as temperatures and pressures fall, the precipitation of dissolved burdens takes place and our ore-bodies are believed to result. Gradually the source of water and its store of energy become exhausted; circulations die out and the period of vein-formation, comparatively brief, geologically speaking, closes. Secondary enrichment through the agency of the meteoric waters alone remains to influence the character of the deposit of ore. In brief, and so far as the process of formation of our veins in the western mining districts is concerned, this is the conception which has been gaining adherents year by year and which, on the whole, most fully accords with our observed geologic relations. It accords with them, I may add, in several other important particulars upon which I have not time to dwell.

In closing I may state, that speculative and uncertain as our solution of the problem of the metalliferous veins may seem, it yet is involved in a most important way, with the practical opening of the veins and with our anticipations for the future production of the metals. Every intelligent manager, superintendent or engineer must plan the development work of his mine with some conception of the way in which his ore-body originated, and even if he alternates or lets his mind play lightly from waters meteoric to waters magmatic, over this problem he must ponder. On its scientific side and to an active and reflective mind it is no drawback that the problem is yet in some respects elusive and that its solution is not yet a matter of mathematical demonstration. In science the solved problems lose their interest; it is the undecided ones that attract and call for all the resources which the investigator can bring to bear upon them. Among those problems which are of great practical importance, which enter in a far-reaching way into our national life and which irresistibly rivet the attention of the observer, there is none with which the problem of the metalliferous veins suffers by comparison.

JAMES FURMAN KEMP.

COLUMBIA UNIVERSITY.

SCIENTIFIC BOOKS.

The Tower of Pelée: New studies of the great volcano of Martinique. By ANGELO HEILPRIN, F.R.G.S. Pp. 62 + 23 plates. Philadelphia, J. B. Lippincott Company. 1904.

In the past three years a good deal of literature has appeared concerning the West Indian eruptions of 1902. A part of this is a simple record of observed facts. Perhaps a greater portion is devoted to speculative inquiries into the cause and nature of the eruptions and attendant phenomena, especially those of Pelée, whose remarkable characteristics have excited the curiosity and interest of students in more than one branch of science. The solution of many of the problems is rendered extremely difficult through the lack of sufficient data upon which to support hypotheses, and geologists often are compelled to admit that certain of the problems must remain unsolved. It has been impossible, in many cases, to obtain much-needed information in the field in regard to many obscure matters on account of the continued activity of Pelée, and this must be taken into consideration when an unusual diversity of opinion appears in the views of different observers.

In the present work, which was published nearly at the same time as Lacroix's report, Professor Heilprin presents his views in regard to the origin and nature of the tower of Pelée. The book contains five short chapters, in the first of which the author describes his experiences and the impressions he received on the occasion of his fourth ascent of Pelée,

in June, 1903; the three following chapters are devoted to observations upon the remarkable tower of Pelée, and in chapter V. are 'some thoughts on volcanic phenomena suggested by the Antillean eruptions.'

Stated very briefly, Heilprin regards the tower, or spine, which has appeared from time to time above the summit, as 'the ancient core of the volcano that had been forced from the position of rest in which solidification had left it' (p. 33). After presenting a number of objections to Professor Lacroix's theory, he says, on page 34:

In assuming the tower to have been an ancient neck-core which under enormous pressure had been lifted from its moorings, we at least require no condition that is not provided for by volcanoes. There can be no objection to postulating the existence of such a core here, as in other volcanoes; and if existing, there would seem to be no reason why, under the gigantic force of Pelée's activity, it should not have been dislodged and pushed bodily outward. The reaction upon this contained mass of accumulating heat, and the infusion into it of steam and flows of new lava, would help to explain the 'burnt-out' and scraggy look which from the first had been a characteristic of the tower-rock.

It is, perhaps, unfair to compare this work with the report of Professor Lacroix, who devoted more than six months to a study of what might be termed the daily life of Pelée, and who was aided by a corps of able assistants, but one can not help being impressed and possibly influenced by the abundance of Lacroix's observations, the completeness of his records, and the lucid exposition of his theories; while, on the other hand, one hesitates to agree with certain of Professor Heilprin's views, not necessarily because they are new, but for the reason that they are not supported by sufficient evidence. Thus, in the statement of his opinion concerning the nature of Pelée's tower, he offers a number of somewhat theoretical objections to Lacroix's views and has little more than suppositions upon which to support his own hypotheses; in fact, he does not take into account many of his own observations. Furthermore, there seems to be some inconsistency in his arguments. After stating that in his opinion the tower represents the old core of the volcano, he says, on page 34:

It can not be doubted that the tower was virtually solid to the core, and equally little need one doubt that its temperature was not such as to maintain a fluidal or semi-fluidal interior. Had the tower not been solid, or had it contained much incandescent fluidal matter, the numerous breakages, whether on the flanks or across the summit, which marked the tower's history, would have revealed these conditions many times.

On page 18 the following occurs:

On the other hand, that the tower was rifted and had irregular passages through it, or through parts of it, into which lava was at times injected, is certain; and the members of the Lacroix mission on more than one occasion noticed areas and lines of incandescence in the basal portion of the core, which they associated with flowing lava-masses. On the night preceding my fourth ascent of the volcano, June 12, 1903, the southwest base of the tower was resplendently luminous, made so either by actually rising lava or by a partial remelting of that portion of the structure.

On page 20, in referring to the first appearance of the tower he says:

Indeed, I remark in my report ['Mont Pelée and the Tragedy of Martinique'], that it seemed to me likely that the two glowing masses of fire which shone from the summit, like red beacon-lights, in the morning of August 22, emanated from the two (incandescent) horns that capped the summit of the mountain.

Although these statements are not flatly contradictory, they at least leave a somewhat hazy impression on the reader's mind.

It will be difficult, even for those geologists who hesitate to accept all of Lacroix's brilliant reasoning and explanation in regard to the physical manifestations of Pelée's eruptions, to agree with Professor Heilprin's views, largely because the manner in which they are presented must in many cases fail to convince the reader.

In chapter IV. various observations on the eruptions are summarized; among them are references to the electro-magnetic disturbances, propagation of sound- and shock-waves, etc., together with more local phenomena. In chapter V. the broad questions concerning the cause of vulcanism in cases of such regional

disturbances as those of the West Indies are discussed, and the view is expressed 'that a subsidence of the floor of the Caribbean Basin, causing displacements of equilibrium and forcing molten and other material to the surface, was the inciting cause of the Antillean eruption' (p. 50). The later paragraphs are devoted to an inquiry in regard to the source of volcanic steam, and the two theories, the penetration of sea water, and of land water, are discussed. The author concludes with a statement favoring the theory that hydrated rocks and the magma of the earth's interior supply the water from which the steam of volcanoes is derived. Twenty-three excellent half-tone plates of the tower of Pelée, eruptions, etc., complete the volume.

ERNEST HOWE.

THE BELGIAN ANTARCTIC EXPEDITION.

Resultats du voyage du S. Y. 'Belgica' en 1897–98–99, sous le commandement de A. de Gerlache de Gomery. Rapports scientifique: Zoologie. Organogénie des Pinnipèdes. I., Les extrémités, par H. LEBOUCQ. December, 1904. Pp. 20, pl. I.–II. Botanique. Champignons par Mmes. E. BOMMER et M. ROUSSEAU. April, 1905. Pp. 15, pl. I.–V.

Two more numbers of the fine series of Antarctic reports from the Belgian Expedition have been received. In the first we have a discussion of the nepionic stages of the development of the extremities in the Antarctic seals, *Lobodon carcinophaga* and *Leptonychotes weddelli,* deduced from a series of unborn young. Of these twelve belonged to *Lobodon* and four to *Leptonychotes.* None of the specimens was embryonic, ranging in length from fifteen centimeters upward. Nevertheless, a study of the progressive development or gradual reduction of the phalanges, nails and hair in such a well-preserved series is far from uninteresting, and this is what M. Leboucq offers, together with some comparisons with known data relating to other seals and some cetaceans.

The fungi collected by the *Belgica,* with one exception, were obtained in Tierra del Fuego, where ten species and forms new to science were obtained. The Antarctic form was found among the culms of the sole Antarctic grass, *Aira antarctica,* in the state of mycelium, which offers analogies with that of *Collybia racemosa,* and it is possible that it belongs to an *Agaric* related to that species. It comes from Danco Land. The Fuegian forms number fifteen and are fully illustrated by admirably executed plates.

W. H. DALL.

SCIENTIFIC JOURNALS AND ARTICLES.

THE December number (volume 12, number 3) of the *Bulletin of the American Mathematical Society* contains the following articles: Report of the October Meeting of the American Mathematical Society, by F. N. Cole; Report of the September Meeting of the San Francisco Section, by G. A. Miller; 'Note on Loxodromes,' by C. A. Noble; 'Stolz and Gmeiner's Function Theory' (Review of Stolz and Gmeiner's Einleitung in die Functionentheorie, Abteilung I.), by Oswald Veblen; 'Cesàro-Kowalewski's Algebraic Analysis and Infinitesimal Calculus' (Review of Cesaro's Elementares Lehrbuch der Algebraischen Analysis und der Infinitesimalrechnung), by C. L. E. Moore; Shorter Notices; Notes; New Publications.

The January number of the *Bulletin* contains: 'On a Familiar Theorem of the Theory of Functions,' by Edmund Landau; 'Rational Plane Curves Related to Riemann Transformations,' by H. S. White; 'On Lamé's Six Equations Connected with Triply Orthogonal Systems of Surfaces,' by J. E. Wright; 'Certain Surfaces Admitting of Continuous Deformation with Preservation of Conjugate Lines,' by Burke Smith; 'The New Calculus of Variations,' by E. R. Hedrick; 'Granville's Differential and Integral Calculus' (Review), by E. B. Van Vleck; 'The Foundations of Science' (Review of Poincaré's Science et Hypothése), by E. B. Wilson; 'La Mécanique Statistique' (Review of Gibb's Statistical Mechanics), by Jacques Hadamard; Notes; New Publications.

The American Naturalist for December contains the following articles: 'Ecology of

the Willow Cone Gall,' by Roy L. Heindel, showing the importance of galls to the insect world; 'Forest Centers of Eastern North America,' by Edgar N. Transeau, the term being used to designate the distribution of trees about the region where they attain their best development; 'Mandibular and Pharyngeal Muscles of Acanthias and Raia,' by G. E. Marion, who finds that from the peculiar shape of the head the ray possesses a few muscles not found in the dogfish.

Bird-Lore for November-December is a thick number, having for its general articles 'The Structure of Wings,' by W. M. Wheeler; 'The Growth of a Young Bird,' by E. R. Warren, illustrated with pictures of birds at various stages of growth; 'Some Early American Ornithologists—Alexander Wilson,' by Witmer Stone; 'Blue Jays at Home,' by Wilbur F. Smith; 'The Story of a Tame Bob-White,' by J. M. Graham, and 'The Feeding Habits of the Northern Phalarope,' by Frank M. Chapman. W. W. Cooke contributes the thirteenth of a series of papers on 'The Migration of Warblers' and William Dutcher the seventeenth Educational Leaflet of the Audubon Societies, devoted to the American goldfinch and accompanied by a colored plate. The Annual Report of the National Association of Audubon Societies for 1905 covers fifty pages and is encouraging reading, showing steady increase and interest in the matter of bird protection.

The Museums Journal of Great Britain for November has articles on 'The Formation of Local Illustrative Collections in Museums,' by John Maclauchan, showing how much has been done in Dundee and what may be done elsewhere; 'The Exhibition of Fresh Wild Flowers in Museums,' by G. A. Dunlop. The notes, as usual, form an important part of the number.

The Journal of Nervous and Mental Disease for December opens with a discussion of the effect of diet upon epilepsy, by Dr. A. J. Rosanoff, including the report of some experiments, from which the author concludes that the organism of the epileptic can not take care of proteid material as it is taken care of by the healthy organism, and that consequently proteids should be replaced in his diet by fats and carbohydrates as far as is consistent with the general health. Dr. M. A. Bliss follows with a report of twenty-four cases of multiple neuritis of obscure origin observed by him among the patients of an insane asylum. Dr. Hecht's elaborate paper on dementia præcox, begun in the previous number, is concluded in this issue.

SOCIETIES AND ACADEMIES.

THE GEOLOGICAL SOCIETY OF WASHINGTON.

At the 171st meeting on November 22 the following papers were presented:

Artificial Wollastonite and Pseudo-wollastonite: Mr. Fred E. Wright.

Mr. Wright described the results of an extended chemical, physical and mineralogical study of the mineral wollastonite by Drs. E. T. Allen, W. P. White and himself, of the U. S. Geological Survey and Carnegie Institution. In the course of their investigation they not only produced artificial wollastonite crystals identical with the natural mineral, but also observed interesting facts bearing on the conditions of its formation which are of geologic significance. It was found that on heating both natural and artificial wollastonite crystals up to the melting point, 1,512° C., an inversion in the solid state took place at 1,180° C. to a second form called pseudo-wollastonite which has never been found in nature and which differs materially from the original substance in optical properties. On cooling, the second form does not revert to wollastonite under ordinary conditions and can only be induced to do so in the presence of some flux such as calcium vanadate. The importance of the inversion temperature (1,180°) as a definite point which is uninfluenced by surrounding magmatic conditions except pressure, was emphasized, and the inference drawn that since pseudo-wollastonite does not occur in nature while wollastonite is found usually in limestone contact aureoles of eruptive rocks where pneumatolytic solutions have been active and all minerals formed contemporaneously, the inversion temperature places a prob-

able upper limit on the temperature of solutions emanating from intrusive magmas. The rare occurrence of wollastonite in eruptive rocks was also discussed, and difficulties of drawing conclusions as to the temperature of their intrusion discussed, and the views of Dr. G. F. Becker on the subject briefly cited.

An Area of Faulting in Central Pennsylvania: MR. GEO. H. ASHLEY.

The region described is one in which extensive mining operations have permitted the mapping of a large number of faults and their minute examination in many cases. The feature upon which most stress was laid was the fact that the great majority of the faults run in lines transverse to the general structure of the region, and where the whole fault from end to end has been found in a single mine working, it appears to be of the nature of a long transverse buckle, which is broken down longitudinally. The resulting faults have all the appearance of normal faults and often present a much complicated series of breaks with the intermediate blocks tilted or dropped down, as is common with a broken arch. The speaker's main argument was that in attempting to account for the faults, resource must be had to the pressure which folded the rocks of the region, their normal appearance being due to the fact that unequal resistance to that pressure allowed the buckling of the strata in the lines of pressure, which buckles or small folds afterwards broke down to the positions in which they at present are seen. Several charts were exhibited illustrating the features discussed.

ARTHUR C. SPENCER,
Secretary.

THE KANSAS ACADEMY OF SCIENCE.

THE thirty-eighth annual meeting of the society was held in Lawrence on December 1 and 2, with over sixty members present from different parts of the state. The address of the retiring president, Professor L. C. Wooster, was given on Friday evening on 'The Development of the Sciences in Kansas.' The academy was divided into two sections, for reading of papers, of which sixty-five were presented. Among those of more general interest, the following are noted: "A New Repetition of the Foucault Experiments with the Pendulum,' J. T. Lovewell; 'Some Recent High-efficiency Lamps,' R. H. Freeman; 'Is the Rain-fall in Kansas Increasing?' F. H. Snow; 'The Variation of Latitude,' E. Miller; 'Dry Periods in Northeastern Kansas, and their Relation to Water Supplies,' W. C. Hoad; 'Some Properties of the Alloys of the Ferro-magnetic Metals, Considered from the Standpoint of Osmond's Allotropic Theory,' Bruce V. Hill; 'Note on Certain Formulas for the Design of Reinforced Concrete Beams,' A. K. Hubbard; 'On the Substituted Ureas,' F. B. Dains; 'Chemical Reactions in Benzene,' H. C. Allen; 'A Chemical Study of the Lime-and-Sulphur Dip,' R. H. Shaw; 'The Gas-and-Oil Engine for Commercial Purposes,' P. F. Walker; 'The Interpretation of Transpiration in Plants,' L. N. Peace; 'Indicator Diagrams,' C. D. Corp; 'General and Special Features of Laboratory Equipment,' J. T. Willard; 'The Botanical Features of the New U. S. Pharmacopœia,' L. E. Sayre; 'The Loup Fork Miocene of Northwestern Kansas,' C. H. Sternberg; 'Notes on Coleoptera,' W. Knaus; 'A Deep Well in Emporia,' A. J. Smith; 'A Little Experiment in Flower-making,' Grace R. Meeker; 'Hygroscopic Structures in the Distribution of Pollen Grains and Spores,' M. A. Barber; 'Secondary Increase in Thickness of *Smilax,*' W. C. Stevens; 'Notes on the White Sheep,' L. L. Dyche; 'On the Malaria Mosquito and the Relative Number in the Vicinity of Lawrence,' S. J. Hunter; 'Comparison of the Microscopic Structure of Stems and Roots,' C. M. Sterling; 'The Disintegration of Cement Plaster under Peculiar Conditions,' E. H. S. Bailey; 'The University of Kansas Expedition to the John Day Region of Oregon,' C. E. McClung; 'A New Qualitative Test for Cyanides,' H. P. Cady.

At the close of the session the following officers were elected:

President—F. O. Marvin.
First Vice-President—B. F. Eyer.
Second Vice-President—J. E. Welin.
Secretary—J. T. Lovewell.
Treasurer—A. J. Smith.

E. H. S. BAILEY.

DISCUSSION AND CORRESPONDENCE.

ISOLATION AND EVOLUTION.

It seems to the writer to be a cause for congratulation that a variety of possible factors of evolution are being discussed at the present time. Just as the factors associated with Darwin's name together with those of the Lamarckian school overshadowed all others in the discussions of the last forty-five years, so now we are in danger of having the 'mutation theory' of de Vries obscure the botanical eye to all other factors. Not that I would endeavor to throw any doubt upon de Vries's facts; they are well authenticated. But they do not, like the socialist's theory of political economy, exclude every other factor from the problem, and we should not, consciously or unconsciously, so consider them.

I have been greatly interested in President Jordan's article on the part played by isolation in evolution. While not disputing the efficacy of isolation as a factor, I would long hesitate to assign it the leading rôle to which President Jordan assigns it. Professor Lloyd's statement of the floral evidence against Jordan's dictum is well put and timely, and emphasizes a fact of distribution which is well known to botanists. If it were necessary to do so, the facts furnished by the distribution of the existing flora could be supplemented by paleobotanical evidence in so far as facts of this nature are available. For instance, during the mid-Cretaceous we have a remarkable series of synchronous or nearly synchronous[1] leaf-bearing strata outcropping from the west coast of Greenland on the north, through Marthas Vineyard, Long Island, Staten Island, New Jersey, Delaware, Maryland and Alabama. These plant-beds have yielded an abundant flora and each locality furnishes a number of closely related species which are largely identical throughout the series. The following genera might be mentioned: *Magnolia, Liriodendron, Laurus, Sassafras, Cinnamomum, Ficus, Aralia,* etc.

[1] The fact of correlation of the containing strata is of no importance for the argument when each outcrop furnishes several species which evidently lived in the same habitat.

Taking the genus *Magnolia* we have the following distribution of species in this region: Greenland, four; Marthas Vineyard and Alabama, five; Long Island, eight; Maryland, three; Raritan formation (N. J.), eight; Magothy formation (N. J.), three. In the genus *Ficus* Greenland furnishes three species and there are four species in each of the other localities, with the exception of Marthas Vineyard. While in many cases leaf species may be regarded as variations of a single actual species, in numerous other instances we can be sure that such was not the case.

It would seem that isolation has not been a primary factor to any large extent in specific differentiation, but that it has operated in a larger way in the development of generic or even larger groups in isolated, particularly in insular, regions. In other words, that it gives a facies to the flora of any region. This is implied in Professor Lloyd's article and is merely the statement of a well-known fact of observation. For instance, the Australian region has a peculiar flora comparable to its marsupial fauna, and it is difficult to imagine that the facts are not explained in one case as in the other by isolation. If we examine this flora we find a number of characteristic types of plant-life, the acacias, eucalypts, the many Rhamnaceæ, Proteaceæ, Santalaceæ, Leguminosæ, etc., the latest with over one thousand species. In all these groups we find numerous species, in many cases an excessive number, closely related, and many with largely identical habitats, so that Professor Lloyd's contention regarding distribution and specific differentiation receives a large measure of support.

Edward W. Berry.

Maryland Geological Survey,
Baltimore, Md.

ON THE HUMAN ORIGIN OF THE SMALL MOUNDS OF THE LOWER MISSISSIPPI VALLEY AND TEXAS.

The following extracts bearing on the theory of the human origin of the small mounds of the lower Mississippi Valley and Texas, resuggested in a recent issue of Science by Mr. D. I. Bushnell, Jr.,[1] may be of interest at this time:

[1] Vol. 22, pp. 712–714.

Foster in his 'Prehistoric Races of the United States' gives the following data:[2]

"There is a class of mounds," remarks Professor Forshey in his manuscript notes, "west of the Mississippi Delta and extending from the Gulf to the Arkansas and above, and westward, to the Colorado in Texas, that are to me, after thirty years familiarity with them, entirely inexplicable. In my Geological Reconnaissance of Louisiana, in 1841–2, I made a pretty thorough report on them. I afterwards gave a verbal description of their extent and character before the New Orleans Academy of Sciences. These mounds lack every evidence of artificial construction, based in implements or other human vestigia. They are nearly round, none angular, and have an elevation hemispheroidal, of one to five feet, and a diameter from thirty feet to one hundred and forty feet. They are numbered by the millions. In many places, in the pine forests and upon the prairies, they are to be seen nearly tangent to each other, as far as the eye can reach, thousands being visible from an elevation of a few feet. On the Gulf margin, from the Vermillion to the Colorado, they appear barely visible, often flowing into one another, and only elevated a few inches above the common level. A few miles interior they rise to two or even four feet in height. The largest I ever saw were perhaps one hundred and forty feet in diameter and five feet high. These were in western Louisiana. There is ample testimony that the pine trees of the present forest antedate these mounds. The material of their construction is like that of the vicinity everywhere, and often there is a depression in close proximity to the elevation."

Professor Forshey then proceeds to state that he encountered hundreds of these mounds between Galveston and Houston, and between Red River and the Ouichita; and they were so numerous as to forbid the supposition of their having been the foundations of human habitations; that the borrowing animals common to the region piled up no such heaps; and finally that the winds, while capable of accumulating loose materials, never distribute them in the manner above mentioned. In conclusion, he adds, "In utter desperation I cease to trouble myself about their origin, and call them 'inexplicable mounds.'"

Colonel S. H. Lockett, in his report on the topographical survey of Louisiana,[3] speaks of them as follows:

There is one feature observed in these prairies, as well as in much of the bottom lands of Ouachita and Moorehouse parishes, quite peculiar and striking, namely, a very great number of small isolated mounds. * * * They are thought by the inhabitants to be Indian mounds, and some of them have been excavated and Indian relics found; but it is hardly probable that so many tumuli, so irregularly scattered over so large a scope of country, can all be the results of human labor, but rather of natural origin and then subsequently used in some cases as burying grounds for the aborigines.

De Nadaillac, in his 'Prehistoric America,' says:[4]

Between Red River and the Wichita[5] they ('the Indian garden-beds') can be counted by thousands. According to Forshey, who described them to the New Orleans Academy of Sciences, these embankments can not have served as the foundations for homes of men. Other archeologists are more positive; they consider that these embankments were used for nothing but cultivation, and that they are intended to counteract the humidity of the soil, still the greatest obstacle with which the tillers of the soil of the plains of the Mississippi Valley have to contend.

The writer has assisted in the excavation of a number of Indian village sites and mounds in Indiana and Kentucky, and has observed and described Indian mounds and village sites occurring in various parts of Louisiana,[6] and feels that the theory of human origin is in no way applicable to the great class of natural mounds which he has observed in Louisiana, Texas and Arkansas and along the Iron Mountain Railroad in southeastern Missouri. The idea of human origin suggests itself at once to every observer, and it strongly attracted the writer when he first examined these natural mounds in Louisiana in 1898, but more extended study showed such a hypothesis to be entirely inadequate.

[2] Foster, J. W., 'Prehistoric Races of the United States,' 2d ed., Chicago, 1873, pp. 121–122.

[3] First Ann. Rept. Topog. Surv. La. for 1869, 1870, pp. 66–67.

[4] 'Prehistoric America,' by Marquis de Nadaillac, translated by N. d'Anvers, 1895, p. 182.

[5] Now spelled Ouachita.

[6] 'Catalogue of Aboriginal Works of Caddo Bottoms, Louisiana,' La. Geol. Survey, Rept. for 1899 [1900], pp. 201–203. [Aboriginal Remains on Belle Isle, Grande Côte, Petite Anse, Louisiana], La. Geol. Survey, Rept. for 1899, pp. 209, 237, 251–253. 'Notes on Indian Mounds and Village Sites Between Monroe and Harrisonburg, Louisiana,' La. Geol. Survey, Rept. of 1902, pp. 171–172.

Opposed to this theory are the following facts: (1) The natural mounds in many cases do not occur in situations favorable for camp sites. (2) They often occur in elevated locations, where there is absolutely no reason for artificial 'elevated sites for habitations.' (3) Regarded as ruined habitations, or wigwam sites, it is very important to consider their vast number and the extent of territory covered. On this basis they would indicate, in many parts of Louisiana and Texas, an intensity and multiplicity of life not now duplicated in any rural community in the world. The sustenance of such vast communities would be entirely beyond the capabilities of the people who built the true Indian mounds. (4) The natural mounds generally occur on the poorest land in the northern Louisiana region, and this fact is strongly opposed to any supposed agricultural significance.

No one doubts that there are numerous Indian mounds throughout this region, but the natural mounds belong to an entirely different class and should not be confused in this discussion with the artificial ones.

A. C. VEATCH.

U. S. GEOLOGICAL SURVEY,
WASHINGTON, D. C.,
December 2, 1905.

SPECIAL ARTICLES.

THE TERMINOLOGY OF ABERRANT CHROMOSOMES AND THEIR BEHAVIOR IN CERTAIN HEMIPTERA.[1]

COMPARATIVE studies of the last few years have brought to light the occurrence of different kinds of chromosomes within the same cell, curiously modified or aberrant structures. These have been described in the spermatogenesis of various insects, as in the Orthoptera (by McClung, Wilcox, de Sinéty, Sutton, Baumgartner, Montgomery, Stevens), the Hemiptera (by Henking, Montgomery, Paulmier, Gross, Wilson), Odonota (McGill), and Coleoptera (Voinov, Stevens); in Chilopoda (by Blackman and Medes); and in Araneæ (by Wallace and Montgomery). I have shown that they are not present in the Protracheata (*Peripatus*). For these a considerable variety of names has been proposed, most of which are good appellatives, but all are inconvenient on account of their length or double form. There is a pressing need for a conciser and more uniform nomenclature, and the following terminology is here proposed to cover the three known kinds of chromosomes found to occur in the groups above mentioned.

Chromosome, a name introduced by Waldeyer, to be retained on account of its long usage as a convenient collective term, and also to be applied in those cases where all the chromosomes of a cell show essentially the same behavior. But when more than one kind occurs in a cell, they are to be distinguished as follows:

1. *Autosoma* (or *autosome*), the usual or non-aberrant chromosomes, called by me previously *ordinary chromosomes.*

2. *Allosoma* (or *allosome*), the modified chromosomes that behave differently from the preceding. This term is much more convenient than the appellative *heterochromosome* previously proposed and used by me, for the latter has an excessive length. Two kinds of allosomes are known in spermatogenesis and may be named respectively:

(*a*) *Monosoma* (or *monosome*), allosomes that are unpaired in the spermatogonia. These have been variously termed *accessory chromosomes* (McClung), *chromosomes spéciaux* (de Sinéty), *chromosomes x* and *unpaired ordinary chromosomes* (Montgomery), and *heterotropic chromosomes* (Wilson).

(*b*) *Diplosoma* (or *diplosome*), allosomes that are paired in the spermatogonia. These correspond to what have been previously denominated *chromatin nucleoli* (Montgomery), *Chromosome nucleoli* (in parte), *small chromosomes* (Paulmier), and *idiochromosomes* (Wilson).

It is after considerable hesitation that I decided to propose these new names, for cellular nomenclature is already heavily overburdened, and I do so in the hope that they may be accepted in the spirit in which they are offered, namely, to attain greater brevity and convenience in writing. When one has to use words frequently he desires them as short as possible. And though I call upon fellow workers to discard their previous names,

[1] Publications from the Zoological Laboratory of the University of Texas, No. 71.

an attitude that would appear ungenerous and might even arouse some hostility, yet at the same time I relinquish previous names of my own that have been employed in various papers and have been adopted to some extent by others. Indeed, it would have been just as satisfactory to me had these emendations proceeded from some other worker.

In the second place a preliminary report upon reinvestigations of the spermatogenesis of two families of the Hemiptera heteroptera will be given in brief.

In the Pentatomidæ there is one pair of diplosomes in the spermatogonia, which always conjugate to form a bivalent one in the early growth period; these relations are exactly as I previously described them. *Trichopepla* only appears to possess an additional pair of very minute components. But I had formerly concluded that such a bivalent diplosome in this family always divides reductionally in the first maturation mitosis, so that its two components would be carried to different daughter cells (second spermatocytes). Wilson has recently shown, however, that in this first mitosis the two diplosomes lie separately in the equatorial plate, and that each divides there equationally; and he finds that in each daughter cell (second spermatocyte) the two daughter diplosomes conjugate in the equatorial plate and are there separated by a reduction division. Wilson is quite correct with regard to this phenomenon, and I had failed to notice (except in *Euschistus tristigmus*) that in the later growth period of the first spermatocytes there takes place a separation of the components of the first bivalent diplosome. Further, I have recently found that in all the genera reexamined each diplosome becomes longitudinally split during the growth period. As to the number of autosomes in the spermatogonia of the Pentatomidæ: in *Euschistus variolarius* there are usually twelve, but in two cells there are at least thirteen, and possibly fourteen; the meaning of these differences I have not yet determined. There are also twelve autosomes in *Euschistus tristigmus, Nezara hilaris, Perillus confluens, Cœnus delius* and *Trichopepla semivittata*. There are fourteen in *Podisus spinosus* and *Cosmopepla carnifex;* my preparations of *Peribalus limbolaris* have faded to such an extent that I was not able to restudy this form.

In the Coreidæ I had previously described the occurrence of monosomes only for *Harmostes, Protenor, Alydus eurinus,* and suggested the possibility of the presence of a monosome in *Chariesterus*. Wilson has recently shown that there is a monosome also in *Anasa,* contrary to the earlier descriptions of Paulmier and myself. Reexamination of my preparations demonstrates that in all the Coreidæ studied there occurs a monosome in the spermatogenesis. It is the odd chromosome of the spermatogonia, always divides in the mitoses of these cells, divides also in the first maturation division, but in the second maturation division passes undivided into one of the daughter cells (spermatids). In all the genera studied this monosome retains its compact form during the growth period of the spermatocytes. Further, in each species studied of the Coreidæ there is a single pair of diplosomes in the spermatogonia, these regularly conjugate in the growth period, and divide reductionally in the first maturation division, as previously described by me. To these observations I can now add that each diplosome becomes longitudinally split in the growth period, and that each divides equationally in the second maturation division; and that they remain compact during the growth period in *Anasa, Corizus, Harmostes, Protenor* and *Chariesterus,* but not in *Alydus* and *Metapodius*. The number of chromosomes in the species investigated is as follows: *Anasa tristis, A. armigera, A. sp.* (from California), *Metapodius terminalis:* eighteen autosomes, one monosome, two diplosomes; in *Alydus pilosulus, A. eurinus, Corizus alternatus, Harmostes reflexulus* and *Protenor belfragei:* ten autosomes, one monosome, two diplosomes; no clear views of spermatogonic monasters of *Chariesterus antennator* were found, but judging from the relations in the spermatocytes there are in the spermatogonium probably: twenty-four autosomes, one monosome and two diplosomes.

The main errors in my preceding work

arose from having neglected to study in certain species the phenomena of the second reduction mitosis.

The preceding observations apply only to the spermatogenesis. Wilson has recently shown that in *Anasa tristis, Protenor belfragei* and *Alydus pilosulus* there is one less chromosome in the spermatogonia than in the ovogonia, and from this most important observation has drawn interesting conclusions relating particularly to the determination of sex. Before the receipt of this last note by Wilson I had determined that this is the case in *Anasa* sp. also.

These observations with further ones on other families will be detailed in a later publication. A point to which I would again draw attention is the value of chromosomal relations as a taxonomic character, discussed in a preceding paper, and within a few months reiterated by McClung. The number of the chromosomes is less constant than relations of behavior. All the Coreidæ have one monosome and a pair of diplosomes; the monosome divides in the first maturation division, probably equationally, but never in the second; the diplosomes conjugate in the growth period of the spermatocytes, remain united until they become separated by a reduction division in the first maturation mitosis, then each divides equationally in the second. The Pentatomidæ possess no monosomes; all have one pair of diplosomes (*Trichopepla* possibly two), which regularly conjugate in the early growth period, later separate, each divides equationally in the first maturation division, they conjugate again in the second spermatocyte and there this bivalent diplosome becomes reductionally divided. Thus one family has only diplosomes, the other these as well as a monosome; in the one the diplosomes divide first equationally, then reductionally, while in the other family the sequence of the divisions is just the reverse.

The conviction almost forces itself upon one that chromosomal relations not only furnish the basis for any understanding of the processes called heredity and differentiation, but also bid fair to become the basis of taxonomy.

Thos. H. Montgomery, Jr.

November 24, 1905.

SCIENTIFIC NOTES AND NEWS.

The American Association for the Advancement of Science and six affiliated societies are meeting in New Orleans as we go to press. We hope to publish next week the official report of the meeting. Reports of the societies meeting with the association at New Orleans and of those meeting in Ann Arbor, New York and elsewhere will follow as soon as possible. Professor Dr. W. H. Welch, professor of pathology at the Johns Hopkins University, has been elected president of the association.

Professor William James, of Harvard University, has been elected president of the American Philosophical Association.

Professor James R. Angell, of the University of Chicago, has been elected president of the American Psychological Association.

M. Henri Moissan, professor of chemistry at Paris, has been elected a foreign member in the Munich Academy of Sciences, and Dr. Warburg, the president of the Reichsanstalt, and Dr. Karl Chunn, professor of zoology at Leipzig, have been elected corresponding members.

Mr. Otto Veach has been appointed state geologist of Georgia.

Dr. Max Uhle, who for the past seven years has been engaged in archeological research in Peru as the head of the Hearst Expedition for the University of California, has concluded the field work of the Hearst Expedition and has accepted the position of director of the National Archeological Museum of Peru. In a letter received from Dr. Max Uhle he states that the government of Peru will prohibit the exploration of archeological sites by foreigners, unless under the direction of the government, and will also prohibit all exportation of archeological objects after January 1, 1906.

We learn from *The Botanical Gazette* that Dr. J. C. Arthur, of Purdue University, is preparing the manuscript on the plant rusts of North America for the 'North American

Flora.' Any assistance through the gift of duplicate specimens or the loan of herbarium sheets will be greatly appreciated.

DR. AUGUST BRAUER, professor of zoology, at Marburg, has been appointed director of the Zoological Museum of the University of Berlin.

DR. A. SCATTENFROH, associate professor of hygiene at the University of Vienna, has been promoted to a professorship and made director of the Institute of Hygiene.

DR. L. FROBENIUS, the well-known German ethnologist, has undertaken an expedition to the region of the Kasai for the study of the native tribes of that part of Africa.

MR. ALEXANDER AGASSIZ, of Harvard University, sailed for Liverpool, on December 30.

PROFESSOR W. A. KELLERMAN will spend the winter in Guatemala with a view to carrying forward the mycological researches begun there last winter.

MAYOR WEAVER has announced the appointment of the following advisory board of physicians to assist Dr. W. M. L. Coplin, of the Philadelphia State Board of Health, in the execution of his plans: Drs. S. Weir Mitchell, John H. Musser, John M. Anders, Hobart A. Hare, J. William White and Henry Leffmann.

DR. WILLIAM STIRLING, recently appointed Fullerian professor of physiology at the Royal Institution, London, will deliver a course of six lectures on 'Food and Nutrition,' at the institution during the months of February and March.

A MEMORIAL to Professor Albert von Kölliker will be erected in Würzburg by the German Anatomical Society, of which he was an honorary president.

WE learn from *Nature* that it is proposed to erect a statue in Freiburg, Saxony, to the memory of the late Professor Dr. Clemens Winkler, who was professor in the Royal Mining Academy at Freiburg, and died in Dresden last year. The proposed memorial is to take the form of a large block of granite decorated with a medallion picture of the deceased investigator and a short account of his life's work.

THE *British Medical Journal* states that Dr. Czerny, professor of surgery at Heidelberg, has founded a gold medal in memory of his father-in-law, the clinician Kussmaul, who died in 1903. The medal, together with a prize of $250, will be awarded every three years for the best German research on therapeutics.

A MEETING to commemorate the hundredth anniversary of the birth of Josef Skoda, known for his study of physical methods of examination and as the founder of the Vienna Medical School, was held on December 11. The bronze bust of Skoda in the hall of the university was decorated with flowers and an address was given by his pupil and successor, Professor von Schrötter.

WALTER B. HILL, chancellor of the University of Georgia, died on December 28.

THE death is announced of Dr. Otto Stolz, professor of mathematics at Innsbruck.

THE United States Civil Service Commission announces an examination on January 24–25, 1906, to fill a vacancy in the position of miscellaneous computer at the United States Naval Observatory, and other similar vacancies as they may occur. Miscellaneous computers are paid by the hour and earn from $800 to $1,000 per annum.

The Geographical Journal, quoting from the *Zeitschrift* of the Berlin Geographical Society (1905, No. 7), states that a scheme has been drawn up for the systematic investigation of the geography of the German African territories. Hitherto, it is felt, much has been lost by the dissipation of energy among various channels, and it is hoped that more valuable results will be gained by the concentration of effort under one organization. The scheme is the result of the deliberations of a committee appointed last year for the purpose, and it is proposed to carry out the objects in view by stationing scientific observers at government stations, attaching them to expeditions, and similar methods. The scope of their researches will embrace 'all branches of scientific knowledge which have to do with the earth's surface, its vegetable, animal and human inhabitants.'

We learn from the *Journal of the American Medical Association* that the Copenhagen and the Berlin academies of science have united in publishing a catalogue of all the Greek and Latin medical writings that have been handed down to us from antiquity. This catalogue is to be preliminary to the suggestion that the International Association of Academies of Science undertake the task of publishing a complete scientific edition of the collected works of the physicians of antiquity. The plan is to be proposed at the next general meeting of the delegates of the association, which will be held at Vienna during the spring of 1907.

UNIVERSITY AND EDUCATIONAL NEWS.

By the will of the late Dr. George S. Hyde, $50,000, the income of which is to be paid to his brother and sister during their lifetime, will on their deaths revert to the Harvard Medical School, to be used as the trustees of the college see fit.

The following buildings are under course of construction at the University of Arkansas: a dairy building, an agricultural hall, an additional boy's dormitory, a woman's dormitory, a chemical building.

At the recent special session of the state legislature the University of Wisconsin was again authorized to draw its income from the general fund of the state treasury, as according to the new method of appropriating funds for the university by setting aside two-sevenths of a mill on all taxes, the university income fund does not become available until February each year, whereas the university budget has always been estimated on the basis of the fiscal year, which extends from July 1 to June 30 of each year. A misunderstanding of the circumstances gave rise to a report that the university had a deficit, but the report of the legislative committee appointed to consider the matter exonerated the university authorities completely and showed that at the end of the fiscal year next June there will be a surplus, not a deficit, in the university accounts. On this point the report states: "According to the budget for the present year it is estimated that the present appropriations for the university are ample and will meet all expenses in maintaining the institution, and will leave a balance on hand for the fiscal year ending June 30, 1906." "That the two-sevenths mills tax," the report points out, "together with a special appropriation of $200,000, both provided for by chapter 320 of the laws of 1905, it is estimated will provide enough money to pay for the permanent improvements above mentioned [the purchase of land and preparation for additional buildings] over and above the amount required for other purposes."

Dr. George W. Atherton has resigned the presidency of the Pennsylvania State College.

Miss Alice L. Davison, Ph.D. (Pennsylvania), has been appointed teacher of chemistry in the College for Women, Columbia, S. C.

Dr. A. J. Ewart, special lecturer in vegetable physiology, Birmingham University, has been appointed professor of botany in the University of Melbourne, in succession to the late Baron von Müller.

The Council of King's College, London, has elected Mr. Harold A. Wilson, M.A., D.Sc., M.Sc., fellow of Trinity College, Cambridge, to the chair of physics vacated by Professor W. Grylls Adams, F.R.S.

Professor Rhys Davis, secretary of the Royal Asiatic Society, has been appointed professor of comparative religions at Manchester University.

Dr. G. A. Buckmaster has been appointed assistant professor of physiology at University College, London University.

The general board of studies of Cambridge University has appointed Mr. J. G. Leathem, M.A., fellow of St. John's College, university lecturer in mathematics until Michaelmas, 1910, and has reappointed Mr. C. T. R. Wilson, M.A., F.R.S., fellow of Sidney Sussex College, lecturer in experimental physics for five years from Christmas, 1905.

Mr. William Wright, D.Sc., M.B., Ch.B., F.R.C.S., has been appointed lecturer on anatomy at the Middlesex Hospital Medical School.